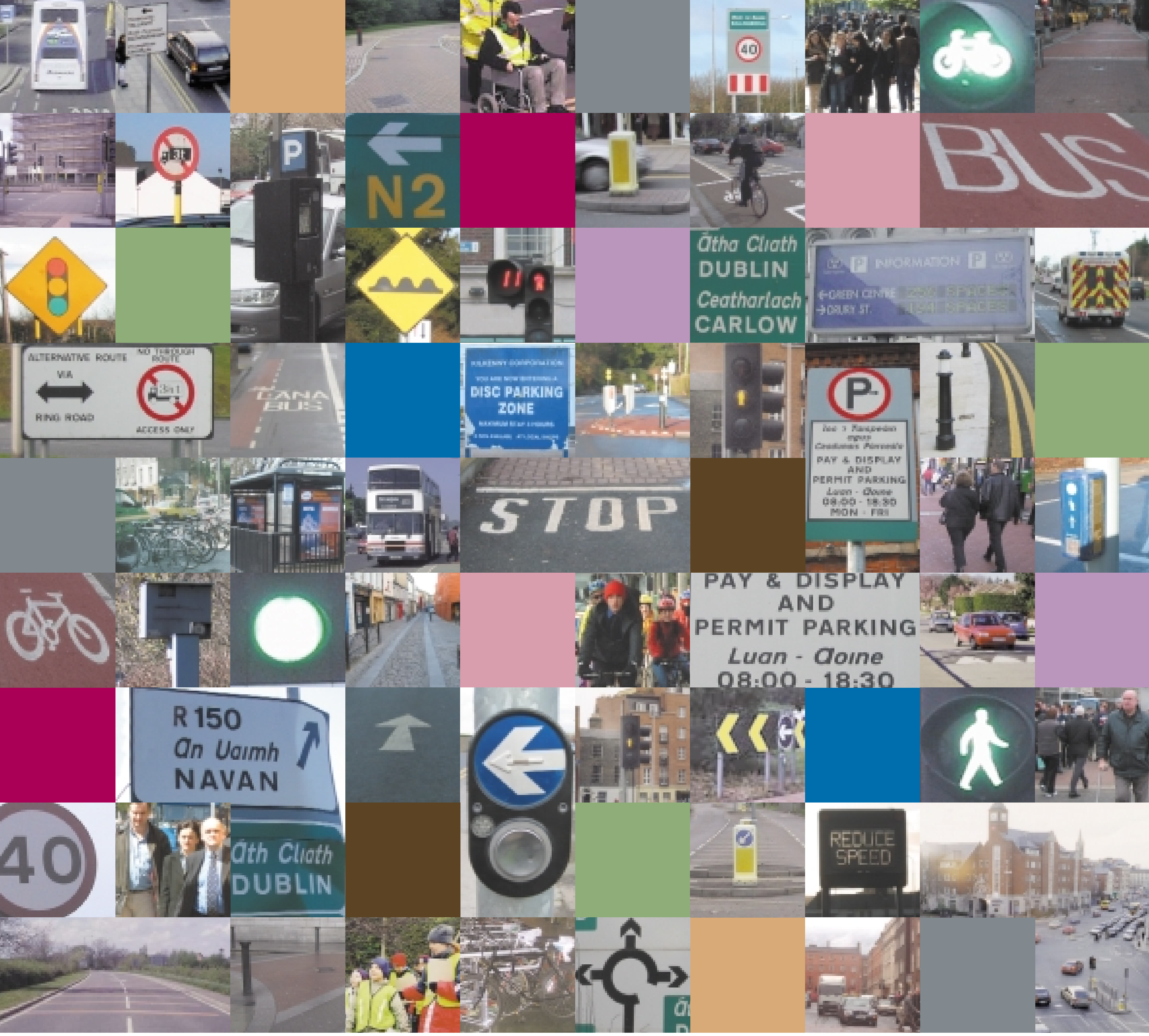

Traffic Management Guidelines

NDP
NATIONAL DEVELOPMENT PLAN

AN ROINN COMHSHAOIL AGUS RIALTAIS ÁITIÚIL
DEPARTMENT OF THE ENVIRONMENT AND LOCAL GOVERNMENT

dto

Department of Transport
An Roinn Iompair

Traffic Management Guidelines

NATIONAL DEVELOPMENT PLAN

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DEPARTMENT OF THE ENVIRONMENT AND LOCAL GOVERNMENT

Dublin Transportation Office
Oifig Iompair Átha Cliath

Department of Transport
An Roinn Iompair

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FOREWORD

The purpose of this Traffic Management Guidelines manual is to provide guidance on a variety of issues including traffic planning, traffic calming and management, incorporation of speed restraint measures in new residential designs and the provision of suitably designed facilities for public transport users and for vulnerable road users such as cyclists, motorcyclists and pedestrians (including those with mobility/sensory impairments). It also focuses on how these issues must be examined and implemented in the context of overall transportation and land use policies.

The manual has been prepared in line with current national and regional transport strategy guidelines that promote sustainability and accessibility, through improvement to, and better management of, the transport system. National, regional and local strategies set the objectives for transportation and traffic management schemes and this manual outlines the techniques and tools available to assist in the delivery of these objectives.

It is intended that this manual will provide assistance to a wide range of people including local authority officials, developers, voluntary organisations and the general public and also government departments and their agencies. In particular, it provides guidance for engineers, planners, architects and policy makers working on behalf of local authorities, developers, government departments and also for An Garda Siochana.

Chapters in this manual should not be read in isolation but in the context of the overall document. References to other relevant sections of the manual are provided at various points in the manual. Source documents and documents which contain additional information on related topics are also referenced. It should be noted that any measures suggested in this manual need to be considered and applied with due care and forethought and should not be relied upon in isolation from other sources of advice and information. Users of the manual should also be conscious of changes which take place in legislation on an ongoing basis.

References to both metric and imperial vehicle speeds are given in this document. In general, design tables for new roads are given in km/h while vehicle speeds from studies carried out in the UK are given as mph. In addition, while there is a firm intent to move to metric speed limits in Ireland, in 2004, current speed limits are regulated for in miles per hour. In this time of transition, it has been necessary to reference both metric and imperial vehicle speeds.

This manual is being jointly issued by the Department of the Environment and Local Government (DoELG), the Department of Transport (DoT) and the Dublin Transportation Office (DTO). The role of Phil Cook, TMS Consultancy (Vanguard Centre, University of Warwick Science Park, Coventry CV4 7EZ) in drafting the manual is gratefully acknowledged. Decisions regarding the final contents of the manual were taken by the sponsoring organisations.

The role of Michael Aherne, DTO, Robert Kelly, Wexford County Council (and formerly DTO) and Dominic Mullaney (DoELG) in overseeing this manual is acknowledged as is the role of the members of the Consultative Committee as listed hereunder:

Brendan Coleman, Dublin City Council
Finbar Crowley, NRA
Sean Hogan, DoELG
Willie Horgan, Dun Laoghaire Rathdown County Council
PJ Howell, Fingal County Council
Gerry Lawlor, Dublin City Council
Eoghan Madden, Dublin City Council
Therese MacAteer, Forum of People with Disabilities
Eugene McDonagh, Dun Laoghaire Rathdown County Council
David O'Connor, Fingal County Council
Michael O'Driscoll, Manor Park Homes
Derry O'Leary, Dublin Bus
Tim O'Sullivan, Dublin City Council
Anthony Reddy, Anthony Reddy Associates
John Tuomey, An Garda Siochana

The comments received from Andrew Baker of the Irish Guide Dogs for the Blind were also appreciated.

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chapter 1 Traffic Management and Sustainability

1.1 Introduction

Purpose

The purpose of this manual is to provide a source of information and guidance on traffic management issues. The manual has been prepared in line with current national and regional transport strategy guidelines that promote sustainability and accessibility through improvement to and better management of the transport system. The strategies will set the objectives for transportation and traffic management schemes (see 1.2) and this manual outlines the techniques and tools available to assist in the delivery of these objectives. For any given transportation/traffic management proposal it is important that the objectives are achieved using appropriate techniques

It is intended that this manual will provide assistance to a wide range of people including local authority officials, developers and Government Departments and agencies. It covers general best practice principles in the areas of traffic management and sustainability, road safety and traffic calming and land use planning and development. It provides guidance for engineers, planners, architects and policy makers working on behalf of local authorities, developers, government departments and also for An Garda Siochana. Chapters should not be read in isolation but in the context of the overall document.

Sustainability

The achievement of a sustainable environment and transport system is one of the greatest challenges facing us in the 21st century. This challenge has major implications for transport professionals.

At its simplest level, sustainability is about the consumption and management of limited natural resources in a way that meets the needs of today's world without compromising the needs of future generations. A principal challenge is to strike a more sustainable balance between protecting/ enhancing the environment and maintaining economic vitality.

Good and efficient transport links are vital for the economy of the country. However, the transport sector places huge demands on limited natural resources such as oil and is a major contributor to environmental pollution. In Ireland transport accounts for over 17% of national CO_2 emissions with three-quarters of this coming from road traffic. Levels of these emissions are rising[1].

The main challenges for the transport sector are to reduce the need to travel and to achieve more sustainable modes of transport that do not have such adverse environmental impacts, whilst maintaining economic vitality.

Economic growth and its impact on traffic

Since the early 1990s there has been much higher economic growth in Ireland than was previously encountered. Table 1.1 on the following page illustrates some of the effects of this.

The demand for travel has increased substantially since 1990. Most of the trips that have been generated have been taken up through the increased use of private cars. This has increased pressure on the road network and congestion has increased markedly.

Congestion costs business and industry millions of Euro every year. The increased pollution damages health and the environment. Congestion in the Greater Dublin Area has already led to a significant increase in peak hour journey times for private cars in 2000 compared with the mid-1990s.

Increasing congestion brings with it increases in concern about road safety. Public transport reliability and journey times suffer and the service can deteriorate. This is known as the "Transport Vicious Circle" and is illustrated in Diagram 1.1.

Transport Planning Context

National transport policy since the mid-1990s has reflected concerns over sustainability.

The Dublin Transport Initiative[2] (DTI) Strategy was introduced in the early 1990s and is an integrated approach to transportation planning in the Greater Dublin Area. It is based around a broader vision of the area as a safe, thriving and attractive place in which to live, work, visit and socialise.

The DTI involved the production of a long-term transportation strategy (to 2011) and a mechanism for continuous review and revision linked to funding programmes. The DTI dealt with all forms of surface transport (road, rail, LRT, cycling and walking) as well as issues such as traffic management and enforcement. It also took account of related policy areas such as land use, economic development, urban renewal, employment and the environment.

In 1997, the Irish Government issued a document entitled Sustainable Development – A Strategy for Ireland[1]. This Strategy set out an agenda to "green" Irish transport, centring on:

- Making transport more efficient;
- Reducing the environmental impact and the intensity of transport; and
- Support for moves at EU and international levels towards examination and implementation of the internalisation of external costs in transport

Specific actions and initiatives which would be taken in support of these objectives to establish a basis for more sustainable transport included the following:

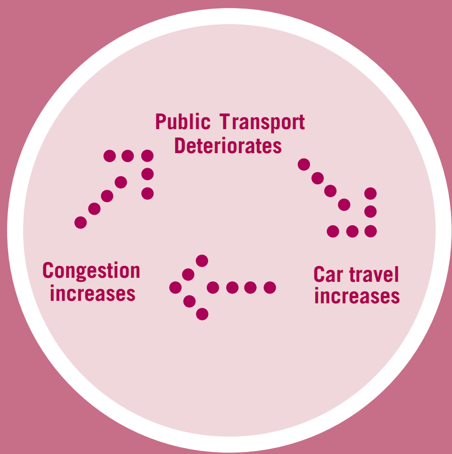
- Minimisation of potential growth in transport demand to be incorporated as a leading consideration in land use planning.
- Government policy and investment for road transport to support necessary economic growth. To this end, the roads programme to continue to target bottlenecks which represent inefficiencies in the infrastructural system.

Table 1.1 Effects of economic growth in the Greater Dublin Area

	1991	1997	2002*
Population (millions of persons)	1.35	1.43	1.5
Employment ('000's)	452	565	720
Cars ('000's)	334	440	615
Household Size	3.36	3.14	3
Motorised Trips ('000's)	172	250	396
Trips per Job	0.38	0.44	0.55

***Preliminary Estimates for 2002**

Diagram 1.1 Transport Vicious Circle



- Increased efforts to be made to manage the existing road network more efficiently.
- Government policy to continue to support and improve public transport systems and infrastructure with a view to increasing their market share. Efficient, cost effective and customer focused development of the rail network to be supported for its economic, social, environmental and regional development benefits.
- The agencies concerned, led by the Department of the Environment and Local Government and the Department of Transport to work together to provide more sustainable and environmentally-acceptable alternatives to private car transport, including better facilities for non-motorised transport and where feasible, improved public mass transport modes.
- Implementation of the Dublin Transportation Initiative to be intensified.
- Noise controls to be developed under the roads (or other) legislation to limit permissible noise form roads transport.
- Opportunities for non-motorised transport to be improved. This will include increased provision of cycle lanes and safer facilities for pedestrians.
- The Department of the Environment and Local Government and appropriate agencies, such as Dublin Transportation Office, to actively encourage greater public awareness of the unsustainable aspects of increasing use of vehicle transport.

There were many other actions and initiatives set out in the 1997 Strategy in respect of transport.

Against this background, there has been a major change in the emphasis in transport schemes in urban areas. Such schemes now seek to promote the more sustainable modes of transport such as walking, cycling and public transport. Considerable investment has taken place in recent years to combat the decline in these modes of transport.

In September 2000, the Dublin Transportation Office (DTO) published the outline of its integrated transport strategy in "A Platform for Change[3]". This document takes account of the Strategic Planning Guidelines for the Greater Dublin Area which were published in February 1999. The DTO’s "Platform for Change" (the DTO Strategy) provides an overall planning framework for the development of the transport system in the Greater Dublin Area.

The National Spatial Strategy [4] (NSS) was launched in November 2002. It outlines in detail the approach to meeting the Governments objective for more balanced regional development over the next 20 years. It also sets out indicative policies in relation to the location of various types of development. The NSS will, in turn, provide a national level spatial policy structure to inform the making of Regional Planning Guidelines and Development Plans under the Planning and Development Act 2000. The development plan process in turn establishes the policy context for the assessment of individual development proposals under the planning code.

The National Spatial Strategy[4] (NSS) was launched in November 2002. It outlines in detail the approach to meeting the Governments objective for more balanced regional development over the next 20 years.

1.2 Balancing conflicting priorities and making the right choices

There is a strong relationship between the 3 main attributes of a road network which are shown in Diagram 1.2:

- Function – the position in the road hierarchy or purpose of the road in relation to carrying through traffic or local traffic and in relation to adjacent land uses (see 1.3)
- Shape – the cross section of the road in relation to how space is allocated for different modes of transport such as pedestrians, cycles, buses and general traffic, as well as planting, loading/parking, lighting etc.
- Use – the actual behaviour of road users on a road rather than the design intention

It is important to achieve the correct balance between these factors in any design.

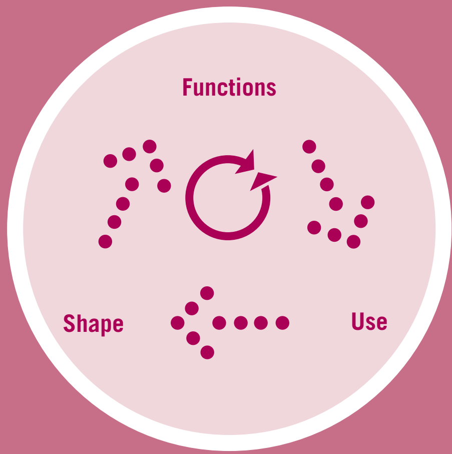
Objectives

Managing the transport network involves dealing with many different objectives. Some of the common ones are listed below:

- environment improvement
- congestion relief
- capacity improvement
- safety
- accessibility
- economic vitality
- politics

Inevitably there will be times when the priorities for each of these objectives within individual schemes could be in conflict with each other. For example the provision of a pedestrian stage at a set of traffic signals may help to improve safety and accessibility but could reduce the throughput of general traffic.

Diagram 1.2 Functions, Shape and Use Triangle



Where choices are available, the public should be consulted over the options. The benefits and potential dis-benefits of options should be explained clearly in order that an informed decision can be reached.

1.3 Managing travel, promoting public transport and the movement of goods

The principal objective of those involved in transportation planning and traffic management is to organise the safe and efficient movement of people and goods. In the past this has been sought primarily through planning for and providing for vehicle movements on the road network. This resulted in the development of a philosophy of predicting future traffic levels and providing road space accordingly.

In countries such as Holland and Germany significant emphasis has been placed on providing high quality public transport and cycle facilities since the 1970's. In Ireland, by comparison, the development of cycle facilities and public transport services has only commenced in earnest, in recent years.

Managing the movement of people and the role of public transport

The private motor car has brought benefits to many people including greater personal freedom and mobility. It is likely to continue to be the most popular means of travel for many journeys for the foreseeable future. However there are questions about its sustainability in the longer term.

Increasing demand for travel by car in large urban areas cannot be accommodated. A more sustainable alternative for these situations is now required.

This has resulted in the need to manage travel options by planning for the travel needs of individual people rather that the needs of their individual vehicles.

A modern bus can carry around 80 passengers in no more road space than two or three private cars so it is considerably more efficient in terms of moving people. Cyclists occupy very little road space and do not use fuel. Cycling provides healthy exercise and does not damage the environment and is an attractive

Bus priority measures

On-road cycle tracks

transport option for short trips. There are strong economic and environmental arguments for giving priority to these more sustainable modes of transport in our network management strategies.

New development should promote accessibility by public transport, cycle and on foot.

Travel management has a role to play in providing the infrastructure to ensure that viable alternatives to the private car are put in place. It should also highlight the alternative modes of travel that are available to the population as they prepare to make their trips.

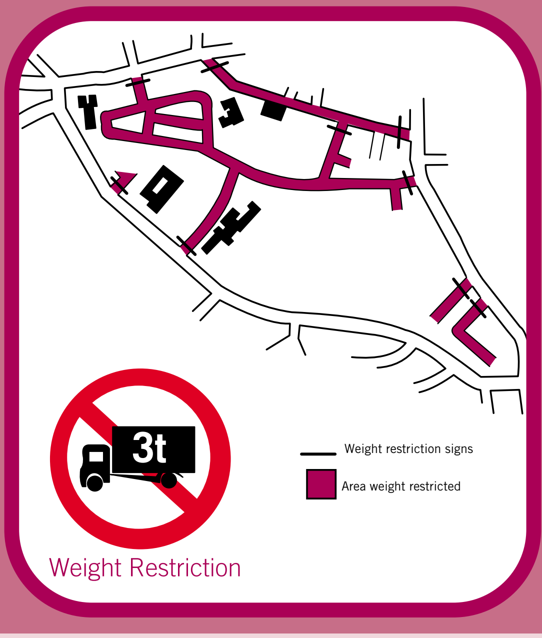
Managing the movement of goods

As well as managing the movement of people, it is necessary to manage the movement of goods. In the Greater Dublin Area moving goods presents huge logistical problems to the industries and commercial activities that rely upon them for their trade and prosperity. The efficiency of that movement is ultimately reflected in the cost of goods and services to the whole community. However, the intrusion and damage caused by the presence of large commercial vehicles in those areas of the city where the road network is totally unsuited to their presence also adds costs and dis-benefits to the community.
The provision of new or improved road links to essential areas of commercial activity that cannot easily be relocated is a first step to managing goods movement. It allows steps to be taken to introduce legal restrictions designed to remove large vehicles from inappropriate streets and to balance the use of streets between loading and other functions.

Emergency service requirements

All traffic management techniques must take into account the legitimate requirements of the emergency services. Unnecessary delays in their response times can have serious consequences for users of their services. The emergency services' views on all traffic schemes should be sought and taken into account wherever possible (See also Chapter 6.3).

Diagram 1.3 Weight Restrictions



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Streets as living space[5]

Streets in urban areas serve many different needs:

- access to property
- areas to socialise
- leisure and play for children
- shopping
- through traffic
- servicing (loading & parking)

Street Functions

It is only in the last few decades that the car has come to dominate every street. Streets are (or ought to be) living spaces, an integral part of the community and the focus of many activities that link together people's lives. The way in which streets are managed and used promotes or discourages a sense of community and makes them an attractive or unattractive place to live.

While certain levels of traffic for access and serviceability can often be accommodated, increasing pressure for parking and movement capacity for vehicles at the expense of other considerations has diminished the vitality and attractiveness of many areas.

This imbalance must be reversed if urban communities are to revive and prosper. Planners and engineers must take the lead in this process.

The introduction of a road hierarchy and the management of traffic onto appropriate roads is a fundamental step in this process.

Closing residential roads to through traffic may be a difficult process but it is a necessary one if future generations are to regain the freedom to consider the roads outside their homes as an integral part of their living space rather than barriers to movement for residents.

1.4 Enforcement

An Garda Siochana has an essential role and responsibility with regard to managing traffic and road safety. The objective of

Streets as a living space

The way in which streets are managed and used promotes or discourages a sense of community and makes them an attractive or unattractive place to live.

traffic policing is to assist in the safe movement of all road users. An Garda Siochana take control of traffic in emergency situations or when traffic congestion occurs and requires their intervention to resolve the problems. They are responsible for enforcing the traffic legislation, including infringements which relate to:

- speeding
- parking
- driving under the influence of drink or drugs
- vehicle safety
- general road user rules and regulations.

They must be consulted over the positioning and use of regulatory signs prior to their installation. They should also be consulted over scheme proposals that are likely to effect their enforcement role e.g. traffic calming schemes.

An Garda Siochana attend the scene of road accidents and manage any temporary traffic arrangements required. They record the details of road traffic accidents which are kept on a national database for statistical and accident investigation purposes. In 1997, the Garda Commissioner established a dedicated National Traffic Policy Bureau within An Garda Siochana to prioritise and co-ordinate Garda action for road safety. An Garda Siochana are also represented on a High Level Group on Road Safety which promotes co-ordination between a number of national agencies involved in road safety. This High Level Group is chaired by a representative from the Department of Transport and also has representatives from the Department of Health and Children, Department of Justice, Equality and Law Reform, Irish Insurance Federation, Medical Bureau of Road Safety, National Roads Authority, National Safety Council and County and City Managers Association. Recent experience of (local authority led) clamping, and the introduction of penalty points, would indicate that penalties directed at mobility are providing the most successful methods of enforcing traffic management restrictions and regulations

1.5 Demand management

Managing the demand for travel is a key element in reducing congestion and the adverse impacts of vehicular traffic on safety and the environment. It involves providing and encouraging alternatives to car use for those who have a real choice in how they travel. Travel managers can help to develop demand management policies as part of their involvement in providing better road facilities for public transport, cyclists and pedestrians. If the demand for travel by private car is left unchecked then congestion will continue to increase. Journey times will increase and the peak hours for traffic will get longer and longer. Safety and the environment will suffer. The economic prosperity of town and city centres will suffer.

Demand management involves implementing strategies and measures aimed at influencing the choice of mode and time of travel for people's journeys. It also involves strategies to reduce the distance that people travel and their need to travel (See Diagram 1.4, next page).

The benefits of managing travel demand are summarised in Table 1.2 (next page).

A wide variety of techniques is available to assist in managing the demand for travel. The main techniques can be split into five broad categories and are shown in Diagram 1.5 and Table 1.3:

- planning and development
- financial
- technology
- traffic management
- travel management plans

Many of the demand management techniques shown in Table 1.3 are dealt with in subsequent chapters of this manual.

The others are discussed briefly below:

- **Planning and development** – Planning policies affect the development of land and the traffic it generates. Policies should aim to reduce the length of journeys and the need to travel. Policies should promote sustainable modes of travel (public transport, cycling and walking). Policies can reduce the number of existing parking spaces, control standards for new developments where appropriate and encourage Green Travel Plans
- **Financial** – Congestion charging and road pricing are mechanisms to charge motorists for the use of particular roads at specific times of day or days of the week to encourage more sustainable modes of travel. Fuel pricing is a more general tool for achieving a reduction in car usage. Levies on workplace and private non-residential parking spaces are also forms of road pricing but they would require new legislation. Subject to certain conditions, it is now possible to obtain tax relief on the purchase of annual bus or rail tickets. This is based on a provision of the Finance Act, 1999.
- **Technology** – Home-working involves working from home or a satellite office closer to home, often with electronic links via computers. This reduces the need to travel to work. Camera enforcement can be used to minimise infringements of traffic laws such as bus lane mis-use, red light running and speeding
- **Travel and mobility management plan** – Examples of this type of plan are Company and School Travel Plans[6]. Such plans encourage employers or organisations such as schools to prepare and implement travel plans. The purpose of these is to encourage their employees (and pupils) to travel in a more sustainable way. They require substantial encouragement and support from road and planning authorities in order to implement them effectively. They may be conditioned as part of a planning application for development of appropriate sites.

Travel Plans should seek to encourage:

- home-working (where appropriate)
- car sharing
- public transport use
- cycling and walking
- cycle parking facilities and links to major bus stops and interchanges
- good access for road users with a mobility impairment.

Diagram 1.4 Reversing the transport vicous circle

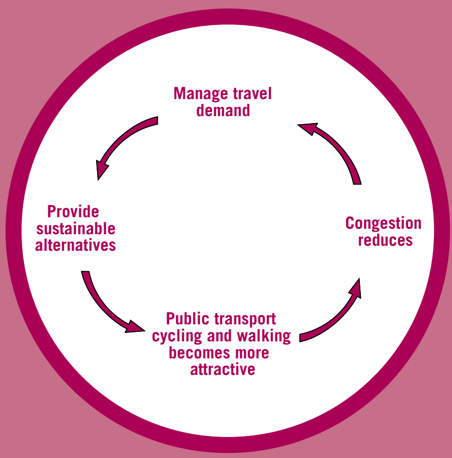


Diagram 1.5 Demand management

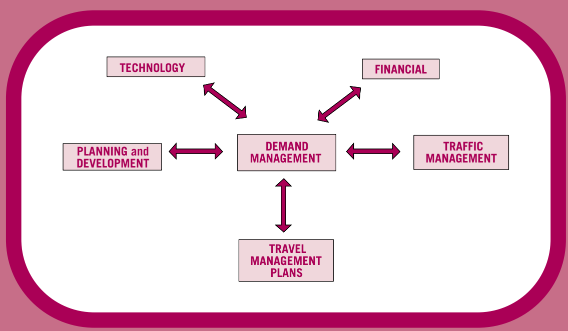


Table 1.2 Benefits of Demand Management

- Reduces the dominance of the car in sensitive areas
- Reduces reliance on the car for all journeys
- Reduces congestion
- Improves economic efficiency
- Improves peoples quality of life by improving the local environment
- Improves the attractiveness and vitality of our towns and cities
- Improves safety for all modes of travel
- Increases the use of public transport

The DTO will be providing guidance on Safer Routes to School following assessment of pilot projects in the Greater Dublin area.

It may be appropriate to set targets for each mode of travel in order to demonstrate a reduction in car usage.

Consideration should also be given to:

- the introduction of a car park management plan which gives priority to essential users and car sharers
- providing incentives and subsidies such as interest free loans, to encourage walking, cycling and public transport
- provision of showers, lockers, secure cycle stands and shelters
- curtailing incentives that encourage car use

Such travel plans can be made attractive to schools and businesses because they can;

- ease pressure on parking facilities
- save time and money on car-based travel expenses and provision of workplace parking spaces
- encourage a fitter, healthier staff
- encourage children into more sustainable travel habits that they can take with them through their life

TABLE 1.3 DEMAND MANAGEMENT TECHNIQUES

Category	Type of measure	Comments/Reference
Planning and Development	Reducing the need to travel through land use planning Sustainable development policy Mixed use developments	This Chapter This Chapter This Chapter
Financial	Fuel pricing Congestion charging or road pricing Workplace parking charges Private Non-Residential (PNR) parking charges Tax relief on annual travel passes	This chapter This chapter Section G, Chapter 16 Section G, Chapter 16 This chapter
Technology	Home-working (Teleworking) Telematics Urban Traffic Control (UTC) and network protection Camera enforcement	This chapter Section H, Chapter 19 Section D, Chapter 10 This chapter
Traffic Management	Infrastructure for sustainable modes of travel – Public transport (including Park and Ride) – Promoting walking – Cycle facilities Traffic restraint measures – Road closures – Traffic calming – Reallocation of road space (for walking, cycling and public transport) Control of parking Truck Routes	 Section F, Chapter 15 Section E, Chapter 12 Section E, Chapters 12 and 14, Provision of cycle facilities, National manual for urban areas Section C, Chapter 6 Section C, Chapter 6 Section C, Chapter 6 Section G, Chapter 16 Section H, Chapter 17
Travel Management Plans	Mobility Management (Green Travel Plans) School Travel Plans	This chapter This chapter

1.6 Road hierarchy

As identified earlier, roads and streets are often multi-functional. The traffic function of each road and street in the network needs to be identified and agreed. In planning travel and movement management strategies for the future, the definition of a road hierarchy is vitally important. It is not appropriate to assume that all roads should be available for all classes of vehicles and traffic. Traffic should be managed onto appropriate roads. The historical failure to do this has resulted in through traffic using residential streets unsuitable for this purpose. This in turn has led to safety and environmental problems.

The classification of the existing road network into a hierarchy helps traffic managers to decide the principal role of each road in the network in relation to general traffic. It assists in strategies for determining measures to manage traffic onto more appropriate roads.

The Roads Act, 1993[7] designates three classifications for roads:

- national
- regional
- local

The power to designate National and Regional roads now rests with the Minister for Transport. Road Authorities can divide local roads into sub-classes and rural local roads are normally divided into local primary, local secondary and local tertiary roads.

In an **Urban context** Primary Distributor roads can be considered to fulfil the role of **National routes.** For the purposes of this document it is convenient to divide **Urban non-national roads** into the categories of District Distributor, Local Collector and Access Roads.

Urban road classification

Descriptions for different Urban road classifications (in terms of function) are set out below:

Primary Distributor Roads

The predominant role for primary distributor roads is to serve long distance traffic. In new designs, such roads cater for fast moving long distance through traffic with segregation between vehicles and cyclists/pedestrians and no frontage access. In many cases these new roads are designed as Urban Motorways. However most existing primary distributor roads have to cater for mixed use traffic in many cities and it is only with the completion of Ring Routes about the cities that these roads can be re-designated in terms of classification and function.

District Distributor Roads

These roads provide links between local districts within urban areas. Whilst they are important traffic routes they can have significant movements of buses and cyclists along them (segregated or on-road) and pedestrians crossing them where there are schools, shops, offices and businesses. Positive measures for pedestrian safety may be required and assistance for cyclists by way of cycle tracks and junction facilities for cyclists may be required where alternative cycle routes are not available.

Local Collector Roads

These roads provide for local journeys and provide links to major routes. Many such roads will have residential and commercial access/frontage and there will be significant movements of pedestrians and cyclists. Designs should not provide unnecessarily wide roads since these encourage higher speeds which can cause problems for the movement of pedestrians and cyclists and lead to accidents.

Access Roads

Designs should aim to keep vehicle speeds low (20mph or less) and allow vehicular access to property and also allow for delivery of goods and servicing of premises. Segregated cycle tracks should not generally be required and pedestrians should have considerable freedom for crossing such roads. In some circumstances shared pedestrian/vehicular areas may be appropriate.

1.7 Land use planning and development

The impact of land use policy on travel

The way in which land is used and developed has a major influence on travel demands and patterns. For example, if the places that people live are not close to where they work, shop etc. then the length of journeys will increase and there is likely to be less choice in terms of their mode of travel.

The development of retail and business parks on the edge of urban areas creates attractive places to shop and to work. Although these developments increase the general economic vitality of the area, they also place heavy travel demands on the transport network. In many cases there has been little alternative for the majority of people but to use their car as the primary means of access. These people-intensive developments may not be well served by convenient public transport links and their comparatively distant location from where people live discourages walking and cycling.

The cumulative effect of this development location policy has been to increase the demand for travel and the length of journeys undertaken. It has also led to the overloading of the road network. Options to reverse this process include (1) promoting more compact and less car dependent urban forms and avoiding a dependence on out of town destinations for employment, retailing and other activities. (2) investing in better public transport links to these development locations or plan for new communities around them. (3) providing cycling and walking networks linkages to the catchment.

Sustainable land use policy

A more sustainable development and land use policy would seek to:

- reduce the growth in the length and number of motorised journeys
- encourage alternative means of travel which have less environmental impact
- reduce the need to travel

In order to achieve a more sustainable land use policy, consideration needs to be given to locating developments that generate significant amounts of travel where there are viable alternatives to car use.

For example, the Netherlands operates a policy with these aims: the ABC location policy[8].

A – Match people intensive land uses (such as residential, retail and office) to areas with good public transport links (bus and rail), easy access by cycle or on foot. Limit parking, support by Park and Ride facilities on feeder routes.

B – Commercial services, sport and recreation should be located at transport interchanges in a district centre, at a bus interchange or near a main road. Discourage parking.

C – Goods intensive uses should be located on main roads at the edges of urban areas and near motorway intersections.

By regulating land use more in line with these principles and improving public transport, walking and cycling links, it is possible to reduce the number and length of trips that need to be made by private car in favour of more sustainable modes. Together with the promotion and adoption of Green Travel Plans for new developments, this could help to reduce the adverse impacts of car usage that are becoming apparent.

Planning authorities should consider this type of sustainable development location policy and promote the implementation of Travel Management Plans when considering planning applications.

Integrated Framework Plans.

Integrated Framework Plans are used to make recommendations for future development type, use mix, density and optimum layout. Higher density development is focused along public transport corridors and employment intensive sites at public transport nodes. Better use of open space and implementation of green corridors to accommodate cycling and pedestrian routes are also identified. These studies are carried out within local Area Action Plan framework and are therefore local area based.

The inextricable link between land use and transportation is identified throughout the Dublin Transportation Office's "A Platform for Change", and most particularly in its "Guidance on Complementary Land Use Policies". The Dublin Transportation Office (DTO) Strategy is complementary to the Strategic Planning Guidelines, and provides the transportation detail for the Guidelines. Each of the Development Plans in the Greater Dublin Area (GDA) has taken into consideration the objectives of the Strategic Planning Guidelines, in accordance with the Planning & Development Act, 2000.

In the Greater Dublin area, the DTO works with the individual local authorities on the integration of the strategic transportation network with land use needs at a local level. In this regard, a number of land use and transportation consultants have been commissioned jointly by the DTO and Local Authorities to carry out "Integrated Framework Plans (IFP's)".

The Integrated Framework Plans aim to encourage the development of land use transportation plans for major development centres in the Metropolitan and Hinterland areas. The plans aim to identify both current and future trip demands generated within these centres and provide a land use and transportation solution consistent with the policies and objectives of the DTO Strategy.

The IFP will look at existing and future zoned land uses and development within the town or district centre and examine traffic movement patterns. Based on the results of this study, the Framework Plan makes recommendations to provide better access for pedestrians, cyclists, local buses and cars. It also makes recommendations for land use development to enhance job opportunities and create better living environments for existing and future residents. The intention of the IFPs is to plan for land use development which will maximise the potential for walking, cycling and public transport.

The IFP will be incorporated into the review of the development plan and will guide future land use development and transportation investment. The Framework Plan and will also identify the following:

- a local bus network to cater for existing and future trip demand.
- significant pedestrian and cycle networks and priority in residential areas and in the town centre.
- identify land uses at appropriate locations and densities to complement the proposed walk and cycle network.

1.8 Layout and design of residential areas

Historically, residential development has tended to centre itself on transport links and centres for trade and commerce.

In recent decades the growth in residential development has been centred primarily on access by road. Housing layouts have been dictated by road hierarchy considerations based around the movement and parking requirements of motor vehicles.

Design consideration for motor vehicles has come to dominate the shape and layout of developments. This has often been to the detriment of other road users and there are many examples where the road design and speed of traffic has discouraged pedestrian and cycle movement because of concerns over safety. It has also led to the creation of areas that are too similar and lack their own sense of local identity.

New developments should seek to create high quality areas with a sense of local identity and community. The design and layout of roads needs to be integrated into the development in a way that is sensitive to the local development rather than to dominate it.

Both the development plan and development control processes should also ensure that new developments are highly permeable in terms of the ability of public transport modes such as buses, and pedestrians and cyclists being able to move through and between adjacent housing developments. Mechanisms such as dedicated bus routes and car restraint measures can place sustainable transport modes at an advantage over the car in accessibility and travel times if their needs are integrated at the design stage. In particular, examples here would include ensuring that local bus services can access the entire development without entering circuitous and time consuming cul-de-sacs. Connections between housing developments by bus only routes could offer faster ways for buses to access residential areas thereby contributing to offering a real alternative to car based transport.

Developments should encourage walking, cycling and easy access to good existing or improved public transport links (through developer contribution where appropriate). Within new residential developments most roads fall into the "access" category of the hierarchy. The main roads into and out of these areas are generally local distributor roads. Within the access category there can be a number of different road types depending on the size and nature of the development. The road type varies with the number of dwellings that each road serves.

Some common types are:

- **Pedestrian and cycle only links** – These are routes (free of motor traffic) that are provided for pedestrians and cyclists, to link various parts of a development. They should provide convenient and direct routes and offer more convenient movement around an area than by motor vehicle.
- **Bus only links** – These can be created to allow public transport better access into an area, whilst restricting use by through traffic.
- **Major access roads (or link and feeder roads) –** These are the main links within the housing areas serving between 100 and 300 residential dwellings. However some UK design guides allow up to 700 residential dwellings off this type of road. Speeds should be physically constrained by the road layout to 30 mph (and 20 mph where possible). Bus lanes should be considered for these roads in the absence of any dedicated bus facility to the main road.
- **Minor access roads (or, mews, courts and squares) –** These generally serve small groups of houses, up to 50 dwellings. Speeds should be physically constrained by road layout to 20 mph. Some of these will have a shared surface for vehicles and other road users.

Design guidelines

Local authorities can publish guidance on how new housing developments are to be designed. This should contain guidance on general layout and design of residential roads and footways/cycleways. This will help developers, planners, architects and engineers to create high quality, safe, sustainable developments.

A number of design guides have been published by local authorities in the UK and are included as references at the end of this chapter. These could form the basis for such guidance but they would need some modification to reflect local and national differences in layout and design of housing, use of materials, local parking and garage use etc. to achieve a sense of local identity.

Developers should provide a conceptual or preliminary design for larger residential developments (100 dwellings or more). This will allow planning and roads authorities to check (at an early stage) that the development is well integrated into the surrounding area and that the road layout is safe for pedestrians and cyclists as well as vehicles.

The preliminary design should include:

- consideration of the main points of access for pedestrians, cyclists, emergency vehicles, public transport, service vehicles and private motorists.
- walking and cycling routes to local facilities such as shops, health centres etc.
- consideration of provision for low design speed (including 20mph) and facilities for pedestrians and cyclists
- any off-site road improvement works, public transport, cycling and walking infrastructure that will be required
- impact on the existing road network in terms of environmental and travel issues (see Assessment of Traffic and Environmental Impacts, Chapter 1.11)
- lighting and landscaping for walking and cycling routes
- the location, amount and impact of car parking
- cycle parking (private safe cycle parking is essential)
- visitor parking for cars and for bicycles

Housing layout dominated by road layout

High quality development with a sense of local identity

Housing development and density

New housing should, where possible, be located:

- in central locations within existing urban areas on vacant, derelict land or through the improvement or redevelopment of existing sites (brownfield sites)
- close (within walking and cycling distance) to employment, leisure, education and shopping facilities
- where there are good public transport links
- as part of high quality mixed use developments

This policy will help to reduce the impact of the development on travel demand.

Guidelines for planning authorities on Residential Density[9] was issued by the Department of the Environment and Local Government in September 1999. This document indicates that in areas well served by local facilities residential densities can be increased (35–50 or more dwellings per hectare) providing that they have good public transport, walking and cycling links.

1.9 Commercial developments

Commercial developments can be made up of a mixture of industrial, retail, business, warehouse and office uses. Many of the design principles for residential roads are applicable to commercial developments. However they differ in that commercial developments will have to cope with larger numbers of long and heavy vehicles.

Pedestrians and cyclists will still wish to get to and from work in these areas so the developments need to be designed in a way that does not create conflict between vehicles and more vulnerable road users. It is appropriate to design for low speeds and incorporate appropriate traffic calming measures but corner radii and road widths will need to be suitable for commercial vehicles (see Section D, Chapter 8).

On-street parking should be discouraged and off-street parking facilities should be provided within developments limited to the intended level of car use.

Good public transport access and facilities should be provided.

Design guidelines

As with housing developments, local authorities can publish guidance on how new commercial developments are to be designed.

Again, a number of design guides have been published by local authorities in the UK and are included as references at the end of this chapter. Some modifications to reflect local and national differences in layout and design of commercial estates would be required.

Conceptual or preliminary designs should be provided to the local authority by developers for developments on parcels of land in excess of 1.2 hectares. These will allow planning and roads authorities to check at an early stage that the development is well integrated into the surrounding area and that the road layout is safe for pedestrians and cyclists as well as vehicles.

The preliminary design should include:

- consideration of the main points of access to the development for vehicles, pedestrians and cyclists
- consideration of provision for a low design speed and facilities for pedestrians and cyclists
- any off-site road improvement works, public transport, cycling and walking infrastructure that will be required
- impact on the existing road network in terms of environmental and travel issues (see Assessment of Traffic and Environmental Impacts, Chapter 1.11)

1.10 Mixed use developments

In order to reduce the need to travel it is important to provide as many facilities as possible locally. Mixed use development can help to achieve this by promoting developments that encompass living, working, education, shopping and leisure facilities in the same locality. Some attempts at such developments have failed in the past because of poor delivery and has led to unattractive and unsafe surroundings. High quality provision and the right mix of facilities are required to make this approach successful.

In providing mixed use developments it is important to segregate access for vehicles to commercial areas from residential areas. It would be inappropriate for significant numbers of commercial and other motor vehicles to drive through residential areas to access commercial areas.

The degree to which mixed uses can be incorporated into a development will depend very much on the scale of the development and its location in relation to other local facilities. Larger scale developments are more viable for mixed use.

1.11 Assessment of traffic and environmental impacts

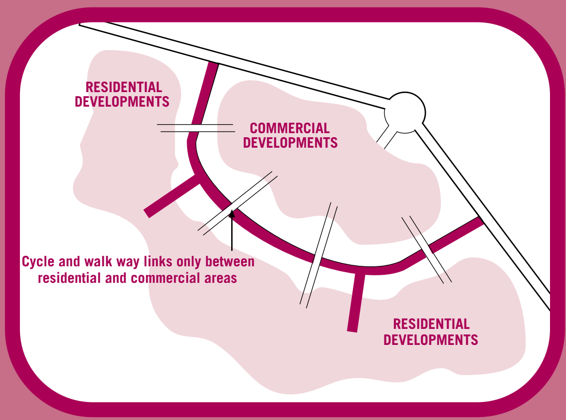
Traffic Impact Assessments (TIAs)[10] and Transport Assessments

Traffic Impact Assessments were used to assess the impacts of developments on the surrounding road network. In the UK there is increased emphasis on accessibility by walking, cycling and public transport, and TIAs are being replaced by a new more inclusive process called Transport Assessments (TAs).

Even modest size developments can have a significant effect on travel demand and capacity of the surrounding transport links. (Invariably, new developments will always impact on the pedestrian route at the front of the development, for instance). In such cases it is considered appropriate that developers should provide a full detailed assessment of how the trips to and from a development might affect the road network and public transport links (including rail and LRT if appropriate).

Diagram 1.6 Commercial Developments

Diagram 1.7 Mixed use Development



With the changing emphasis on promoting the more sustainable modes of transport it is important that this considers all possible modes of travel, not just vehicular transport.

Transport Assessments provide a framework for such studies and should be an impartial assessment and description of both the positive and negative impacts of the proposed development.

There are three key steps in the process:
1. Determination of the need for a TA
2. The scope of the TA
3. The preparation of the TA report

It is necessary to decide which developments should be subject to a TA. One of the simplest ways in which to do this is to set thresholds above which a TA is automatically required. This does not mean that occasional sensitive developments that do not meet these thresholds should not be subject to a TA if considered appropriate.

The scope of the assessment should be agreed between the developer and the planning and roads authorities. This is normally achieved by carrying out a scoping study. This study normally sets out the following information:

- details of data to be collected
- extent of the area to be considered
- key junctions to be considered
- methodology of the study
- year of assessment

The scoping study helps to set out the basis for the full study and pinpoint any potential areas of difficulty, at an early stage.

Table 1.4 Thresholds for Transport Assessments

- Traffic to and from the development exceeds 10% of the traffic flow on the adjoining road
- Traffic to and from the development exceeds 5% of the traffic flow on the adjoining road where congestion exists or the location is sensitive
- Residential development in excess of 200 dwellings
- Retail and leisure development in excess of 1000m²
- Office, Education and Hospital development in excess of 2,500m²
- Industrial development in excess of 5,000m²
- Distribution and warehousing in excess of 10,000m²

It is necessary to decide which developments should be subject to a TA. One of the simplest ways in which to do this is to set thresholds above which a TA is automatically required. (see table 1.4)

The full TA study is then carried out in accordance with any relevant local guidelines that have been agreed. It should consider the items below in an integrated manner:

- a description of the existing conditions at the site
- a description of the proposed development
- details of the modal choice and trip attraction
- trip distribution and assignment
- assessment timescale
- road impacts including access points
- road safety
- internal layout
- parking provision
- public transport
- pedestrians/cyclists/people with disabilities
- junction design
- alternative forms of junction layout

Environmental Impact of road traffic for new developments

Developments can have significant impacts on the environment. There is a need to balance the environmental consequences of a development with the economic benefits that the development brings.

Assessments of environmental impact provide a framework for the analysis of a wide range of local environmental impacts arising from new developments. They should be carried out at an early stage to allow alternative arrangements to be considered. It is important that they are carried out in a comprehensive and consistent way.

Environmental Impact Statements (EIS) are mandatory for developments such as housing developments with more than 500 dwellings, motorways, busways, new or widened 4 lane roads which are more than 500 metres in length in an urban area and for many other major developments.

Even where an EIS is not mandatory it can be useful to use the EIS requirements as a framework for examining proposals.

EIS requirements for road schemes are set out in the European Communities (Environmental Impact Assessment) (Amendment) Regulations, 1999 (S.I. No. 93 of 1999)[19]. While similar in content, EIS requirements for other developments are covered by different legislation and the requirements are set out in Schedules 5,6 and 7 of the Planning and Development Regulations, 2001[20].

The Environmental Impact Assessment methodology can be used to assess developments if considered appropriate irrespective of whether or not an Environmental Impact Statement is legally required.

It is beyond the scope of this manual to consider in detail this procedure but some of the commonly used procedures are listed in the references at the end of this chapter.

Some of the common impacts to be considered are:

- noise
- vibration
- visual impact
- severance
- road user delay and amenity
- safety and accidents
- air pollution
- dust and dirt
- ecology
- heritage and conservation
- flora and fauna

A Traffic Plan should form part of the transportation planning process.

1.12 Traffic Planning

The planning and management of traffic in cities and provincial towns is becoming an increasingly urgent and necessary job. Many towns and urban areas have in the past developed without sufficient attention being given to planning for traffic and managing its effects.

Conflicting objectives of commercial vitality, ease of access/movement, safe environment for all users, residential/environmental amenity can make this process difficult to manage. However with the population set to increase to 4.5m by 2015, and the direct link between economic growth and transport demand it is essential to plan and manage traffic demands in our towns and urban areas if they are to thrive.

There are also very clear road safety reasons for managing and controlling traffic in urban areas. Recent Dublin data suggests that approximately 75% of all fatalities and approximately 43% of all injuries in urban areas are vulnerable road users (Pedestrians, motorcyclists, or pedal cyclists).

It is useful to define what is meant by the following traffic terms:

Traffic Management:

Involves the daily management of the traffic network and the development of programmes and projects which are compatible with the longer term Traffic Plan. Traffic networks should be designed and managed in accordance with the Functions, Shape and Use approach. See section 1.2. Management techniques should include the following:

- Network control (in terms of use of traffic lanes, junctions, traffic signals and roundabouts and possible use of UTC systems)
- Provision of facilities for pedestrians, cyclists, mobility/sensory impaired, public transport, HGV's and taxis as appropriate
- Enforcement of regulations
- Restraint measures - physical, parking, charging, area controls
- Traffic calming / speed management
- Use of pedestrianisation / pedestrian priority streets
- Parking provision for cars (including disabled), bikes, motorbikes, bus and trucks)
- Loading/Servicing /emergency vehicle facilities
- Camera – enforcement/remote monitoring
- Prioritisation of Objectives – not everything can or will fit
- Monitoring and measuring against objectives

Traffic Plan:

A Traffic Plan should form part of the transportation planning process. It should be focused on best use of existing assets (rather than building new alignments). It should be a plan with the following:

- 3-5 year horizon
- Compatible with the County Development Plan
- Multi-modal
- Objective-led

It is often necessary to undertake certain studies to assist in the task of planning for the future. The two main types of study are Traffic Studies and Land Use / Transportation Studies:

Traffic Studies

Traffic Studies should be carried out with the objective of finding short-term solutions and setting medium term goals to improve traffic circulation, pedestrian, cycle, and public transport facilities in an urban area. They should also focus on improving the town centre environment for business, retail and living purposes. They should examine current traffic management policy and recommend implementation of new policy where appropriate.

Depending on the size of the area under study it may be useful to develop traffic simulation and prediction models, however this is often not necessary for smaller towns and conurbations (for a population of less than 30,000). A Traffic Study should however as a minimum include the following:

- Traffic and junction counts
- Pedestrian counts
- Parking Survey (no, location, duration, level of enforcement)
- Loading/Servicing surveys
- Traffic signal assessment
- Survey of public transport facilities and needs
- Maps indicating networks for each model

Outputs from a Traffic Study should include:

- A Traffic Plan with phased implementation
- Costings for all proposals
- Population/traffic growth predications
- Assessment/comments on current Development Plan
- Identification of future transport needs

Regional Land Use / Transportation Studies:

These studies are strategic in nature and, usually require the development of a simulation model of the area under study. Their objective is to establish the longer-term land use and transportation needs of the area under study. They review the current Development Plans and identify proposals and needs for the study area over a 20-30 horizon. They should examine current Land Use/Transportation Policy and recommend the adoption of new policy where appropriate.

It can be useful to carry out a Traffic Study after the Land Use/Transportation Study as one can feed into the other and will result in a short-term implementation strategy with a view to the longer term objectives.

IFPLUTS (Integrated Framework Plan for Land Use and Transportation) is concerned with sustainable growth in development centres within the context of a regional LUTS strategy. Information on Integrated Frameworks Plans can be found in Chapter 1.7

1.13 References

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2

chapter 2 Road Safety

2.1 Road safety strategy

In 2000, 415 people were killed and approximately 10,000 people were injured on Irish roads. In terms of road deaths per 100,000 population, Ireland's rate of 11.0 is close to the average for the European Union (EU). However, there are around 3.0 road deaths per 10,000 licensed motor vehicles and 3.1 pedestrian deaths per 100,000 population. When measured using these parameters, in the EU only Greece and Portugal have worse accident rates. The comparable accident rates for the UK are around half of these values.

Around 70% of fatalities in the Greater Dublin area are vulnerable road users i.e. pedestrians, cyclists and motorcyclists.

The Government strategy for Road Safety 1998-2002 was published in 1998[1]. This outlines the need for a progressive and systematic approach to road safety. It identifies a number of targets to focus action and against which progress can be measured.

The strategy sets out actions across a wide range of policies and agencies involved in or influencing road safety.

The strategy sets out a number of key targets and actions.

Primary targets are:

- to reduce road fatalities and serious injuries by a minimum of 20% by 2002 compared to the 1997 level
- to reduce serious injuries by a minimum of 20% by 2002 compared to the 1997 level

Supporting targets are to:

- to reduce the incidence of excess speeding by 50% from 1997 levels
- to increase the wearing rate for front and rear seat belts to at least 85%
- to reduce by 25% (from 1997 levels) the number of fatal road accidents (commonly drink-related) occurring during the hours of darkness
- to implement specific accident reduction measures at more than 400 additional national road locations

Key new policies and actions in support of the strategy are:

- to extend the use of automatic speed detection systems including the installation of fixed speed cameras
- to commence evidential breath testing for drink-driving
- to extend on-the-spot fines to non wearing of seat belts and other offences
- to develop a penalty points system, which would trigger disqualification following repeated driving offences

The road safety strategy also identifies existing road safety measures that are to be enhanced and intensified:

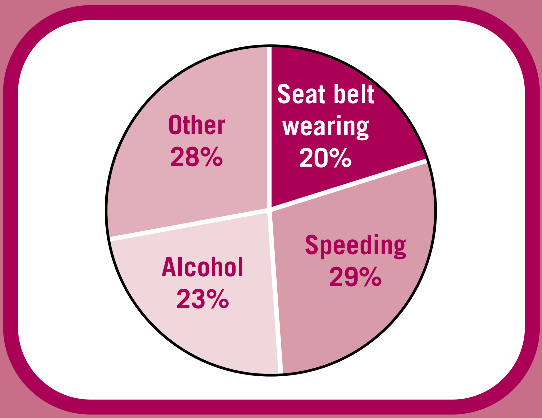
- improved road safety education programmes will be provided for schoolchildren
- information and awareness campaigns will be sharpened on the basis of the clearer priorities set out in the strategy
- Irish Road safety research will be expanded
- Garda IT systems relevant to road traffic enforcement will be upgraded and driver licensing records will be computerised
- roadworthiness testing for cars to be introduced
- National Roads Authority will continue to step up its road safety engineering programmes
- co-operation and co-ordination between road safety agencies will be enhanced pending more fundamental consideration of the organisation of road safety
- increased support for road safety will be provided by the business and voluntary sectors

The contribution of each of the different measures to saving lives has been assessed. Measures to counter speeding, inappropriate use of alcohol and non-wearing of seat belts are together estimated to contribute some 72% of the total improvement targeted by the strategy.

Each road authority should produce a Road Safety Plan to co-ordinate efforts to improve road safety and reduce the number of people killed and injured on roads. This will cover programmes of education, training, publicity enforcement and engineering. Casualty reduction targets should be set locally to assist in achieving the national targets. Some authorities have Road Safety Committees that assist in this work.

Funding is available for road authorities to carry out low cost safety engineering schemes. Each road authority should be pro-active in undertaking programmes of safety engineering schemes.

Diagram 2.1 Estimates of lives saved by various members



2.2 Casualty Reduction and Safety Engineering

One way in which the high number of road casualties can be reduced is by investigating how the accidents happened with a view to designing and implementing engineering measures to prevent more accidents occurring. This topic is dealt with in a separate publication 'A Guide to Road Safety Engineering in Ireland'.[2]

The principles of this approach to reducing accidents are that:

- higher than expected numbers of accidents of a similar type can indicate problems related to the road
- accidents of this type will continue to occur unless the problem is treated
- making changes to the road environment such as altering the road layout, providing signing and road markings, improving or changing the type of junction etc, can change driver behaviour and reduce accidents

Each road authority should produce a Road Safety Plan to co-ordinate efforts to improve road safety and reduce the number of people killed and injured on roads.

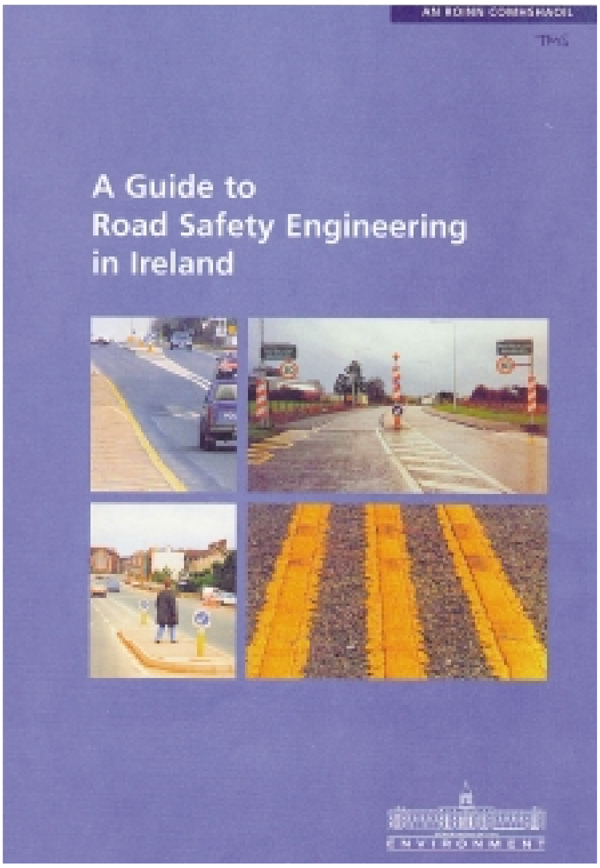
Accident problem locations can be categorised as follows:

- **Single sites** – a discrete location such as a junction with a high number of accidents
- **Route lengths** – whole routes or sections of routes which have a high number of accidents
- **Areas** – Whole areas or parts of an area that have a high number of accidents
- **Mass action sites** – A number of sites with a similar accident problem that could be treated with a similar measure

The safety engineering process involves identifying the problem locations and then analysing the accident data from An Garda Siochana records (C(T)68 reports). The next step is to define the road accident problems so that a range of accident treatments can be identified and evaluated. Once the evaluation is completed the most cost-effective treatments can be selected and implemented. After the schemes have been implemented, their effectiveness should be monitored annually for a period of 3 to 5 years. This will allow engineers to compare the "before and after" records and to determine how effective the measures have been.

Road safety engineering schemes have a strong record of achieving significant reductions in road accidents and casualties. Some typical accident remedial schemes and potential accident reductions are:

- high-friction surface (30% to 60%)
- right-turn lanes (33%)
- pedestrian islands (10% to 50%)
- traffic calming (up to 70%)
- cycle tracks (20%)
- signing and road marking schemes (30% to 50%)



A Guide to Road Safety Engineering in Ireland

Accident Reduction Measure

2.3 Road Safety Audit

Road safety audit is a formal procedure for assessing the accident potential and safety performance in the provision of new roads, road improvements and maintenance schemes. **Whilst safety engineering schemes aim to treat existing safety problems, road safety audit seeks to reduce the accident potential and safety problems of new schemes.**

Road safety audits originated in local authorities in the UK. Most UK local authorities now undertake these on a wide range of schemes. Road safety audits are mandatory on trunk roads and motorways in the UK and are becoming increasingly common practice in other countries around the world. Many EU countries are now seeking to implement safety audit procedures. In Ireland, the NRA has introduced formal safety audit procedures for national road schemes.[3] Dublin City Council has adopted a formal road safety audit procedure for schemes in their area.[4] The Dublin Transportation Office require safety audits to be undertaken on all schemes where they manage the funding.

The aims of road safety audits are:

- to ensure all road schemes operate as safely as practicable
- to minimise accident numbers and severity
- to consider the safety of all road users – especially vulnerable road users
- to improve the awareness of safe design practices by design, construction and maintenance staff

The benefits of road safety audit

It has been estimated that road safety audits can save around 1 casualty per year per scheme[5] when compared with schemes that have not been audited. The benefits for individual schemes vary and may be much higher on larger schemes. The average cost of an injury is approximately €60,000[6] and the cost of a safety audit is generally less than €2,000 for all but larger schemes. Therefore if an audit is undertaken at all three stages of a scheme's design and construction then the costs are likely to be less than €6,000 and lead to savings of €60,000 representing excellent value for money.

What schemes should be audited?

Ideally, all road schemes should be audited but the following categories should receive priority:

- new roads (including residential roads)
- major road improvement works
- traffic management schemes including Quality Bus Corridors and Cycle Tracks
- development schemes
- major junction improvement works
- any scheme which materially affects vulnerable road users
- major maintenance schemes

When should schemes be audited?

Schemes should be audited at various stages of their development.

Stage 1 – Completion of preliminary design
Stage 2 – Completion of detailed design
Stage 3 – Completion of construction / prior to opening to traffic

Stages 1 and 2 can be combined for minor schemes. Generally the earlier in the planning or design process that the audit process is started, the less likely a scheme is to have problems when introduced.

For larger schemes it is beneficial to carry out an audit earlier, at the feasibility stage. Monitoring of the schemes after completion can provide valuable feedback to designers and auditors on the effects of any audit recommendations and changes made to the design. If monitoring is undertaken it is normally carried out 1 year and 3 years after completion of the scheme.

Who should carry out the audits and what skills do they need?

Road safety audits should be carried out independently of the design team. The audit should be undertaken by an experienced auditor or team of auditors. It is very difficult for people to be able to review a scheme from a safety point of view if they do not have substantial road accident investigation and road safety engineering experience. There is no formal qualification in road safety audit, but training in road safety engineering and safety audit is available for those without the relevant experience. Although a safety audit is not a technical check, a working knowledge of design standards and current road safety research is helpful.

Carrying out an audit

The road safety audit is carried out at a number of different stages of the development of a scheme. The audit is concerned about how people will use the scheme in practice as pedestrians, cyclists, drivers etc. It should therefore be carried out from a road user point of view. The audit should be an objective assessment of potential road safety problems. Where possible, audits should be undertaken by a team of two people as this helps to avoid safety problems being missed and ensures that the audit is objective. Larger audits may require an extra person in the team or some assistance from a specialist. An Garda Siochana should be involved in the stage 3 audit and earlier if resources allow.

The safety audit involves examining plans and any other supporting information such as accident data, traffic flows, contract documents etc, from a road user point of view. This examination should consider how different users would cope at different times of day (e.g. dark and light) as well as at different times of the year and in different weather conditions. Measures that will reduce the likelihood or severity of accidents should be included as recommendations in the report. Various checklists are available to assist in the audit process. Checklists can be helpful but, if used, should be used towards the end of the audit to help check that nothing has been missed.

The audit is not just a desktop exercise; it is important to visit the site where the scheme is to be built. This helps to ensure that the topography of the site and traffic conditions can be taken into account properly.

The audit report

The report should be in the form of a list of problems and recommendations. A list of all the plans and other information examined should be included as an appendix to the safety audit report. The report should also list the people involved in the audit and should be signed by the auditors. For stage 3 audits, it is possible that other people such as An Garda Siochana and resident engineers will attend the audit. It is not necessary for them to sign the audit report but they should be listed in the report.

The need for an audit policy and procedure

It is recommended that road authorities have a policy and procedure in respect of road safety audits.

These would identify:

- the type of schemes that would be audited
- the stages of the schemes development at which audits would be carried out
- who would carry out the audits
- who would consider the audit reports and make the necessary decisions

The policy and procedure should set out the management process for undertaking road safety audits.

2.4 Safer Routes to School

Safer routes to school is an initiative which was introduced in the United Kingdom to improve the safety of the routes children use to get to and from school. It is aimed at reducing the barriers to walking and cycling to school and reducing the number of car-based journeys to and from school.

The increasing use of cars for taking children to school has contributed not only to general congestion on the road network, but to dangerous parking around schools. Traffic levels and the speed of vehicles on the routes to and from school are a major parental concern. They deter parents from allowing their children to walk or cycle to school. However the concerns about road safety may not be reflected in the number of accidents that have been recorded in the area.

Successful projects require substantial input and commitment from the schools and their pupils. Schools and schoolchildren should take an active role in defining problems and identifying solutions. They also require support both organisationally and financially from the local authority. Many children live within a distance of school that would be relatively easy to walk or cycle, if it were safe and convenient to do so. It is customary to start the process with a survey of how children and staff travel at present and what discourages them from walking or cycling. Some of the issues raised will be about safe and convenient cycle parking facilities at the schools and may need a review of school policies on these issues. Other issues will relate to the need to improve or provide better cycle tracks and crossing facilities for pedestrians and cyclists. Measures such as traffic calming to reduce the speed and volume of traffic should also be examined.

A number of schools in the UK now have 'walking buses' in which children get into groups and walk to school together. These are supervised by parents/ guardians and are a popular way of encouraging safe walking for younger children.

In order to change people's travel patterns it is necessary to generate enthusiasm and a willingness to change, as well as engineering measures to make roads safer.

Safer routes to school treatment

Walking Bus (in UK)

It is important therefore that the schools, children and parents are committed to this or little change in travel patterns will be achieved despite a considerable investment in engineering measures.

The safer routes to school initiative can be applied to all age ranges of children from pre-school up to college and university.

The four key objectives for safer routes to school projects are:

- To reduce accidents and fear of accidents
- To promote modal shift from private cars to walking, cycling and public transport
- To improve the front of school environment so that pupils who are walking or cycling are the pre-eminent mode during arrival and departure times
- To improve levels of fitness and therefore health

The Dublin Transportation Office will be producing a report on the results of a number of their pilot Safer Routes To School projects, and guidelines for their suitability and introduction in the future.

The safer routes to school initiative embraces the sustainable transport approach to travel. Where it has been implemented successfully, significant modal shifts have been recorded. There are a number of published case studies from schemes in the UK and these are listed in the references.

2.5 Improving facilities for vulnerable road users

"Vulnerable road users" is a term for people who walk, cycle and use mopeds, scooters or motorcycles. Horse riders can also be considered in this category. They are vulnerable because their mode of travel offers them little protection from crashes, unlike in cars, vans etc. Part of the sustainable transport agenda is to encourage people out of their cars to undertake more journeys by walking and cycling. The main barriers to walking and cycling are the absence of safe facilities for cycling and for crossing roads. Efforts need to be made to establish safe and convenient cycle track networks if cycling numbers are to be improved significantly. More crossings need to be provided for both

Dished crossing for wheelchair access

Poor design of cycle/pedestrian facility pedestrians and cyclists. Similarly, existing crossings may need to be improved in order to give vulnerable road users more priority. The provision of cycling facilities is dealt with in detail in 'Provision of Cycle Facilities, National Manual for Urban Areas'. Other vulnerable road user issues are dealt with in Section E of this manual.

2.6 Mobility Impairment

People with mobility impairments such as blindness, partial-sight, deafness, and a variety of walking problems including wheelchair users are the most vulnerable road users of all. Some people may have more than one impairment e.g. they may be blind and deaf. People with heavy shopping, pushchairs or small children can also be considered in this category.

There are no official figures available for people with mobility impairment in Ireland. Walking (or use of wheelchairs) is the main mode of transport for most mobility impaired people.

Facilities for people with mobility impairment are dealt with in Section E, Chapter 13.

2.7 Road User Audit

Road user audit is a check of a scheme to ensure that all road users, especially vulnerable road users, are provided for. It is an opportunity to introduce or improve facilities for specific road user groups. The process is carried out at various stages during the development of a scheme, much the same as with safety audit (See Chapter 2.3). Road user audit differs from road safety audit in that it is not concerned solely with safety issues.

Over a period of time, adopting a practice of road user audit should assist in the development of a transportation culture where improving amenities, and the encouragement of walking and cycling become second nature. This will contribute to traffic reduction and lead to environmental benefits.

The Dublin Transportation Office is developing checklists and procedures to assess the design of transport proposals from the point of view of catering for pedestrians, cyclists, buses, cars and goods vehicles.

Road User audit is dealt with in more detail in Section E, Chapter 14.

2.8 References

1. The road to safety: Government Strategy for Road safety 1998 – 2002 – Department of the Environment and Local Government. (available from Road Safety and Traffic Division, Department of Transport, Findlater House, Dublin 1. Tel 01 8882330, Website www.transport.ie)

2. A Guide to Road Safety Engineering in Ireland – Department of the Environment. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

3. NRA HD 19/00 Road Safety Audits, and NRA guide to Road Safety Audits. Available from the National Roads Authority, St Martin's House, Waterloo Road, Dublin 4, Ireland. Tel 01 660 2511 Fax 01 668 0009

4. Guidelines and Procedure for the Introduction of Road Safety Audit in Dublin City Council. Available from Dublin City Council, Civic Offices, Wood Quay, Dublin 8.Tel 01 6722222
Fax 01 6773612

5. Guidelines for The Safety Audit of Highways – The Institution of Highways and Transportation – UK. (Available from IHT, 3 Lygon Place, Ebury street, London SW1W 0JS, Tel +44 20 7387 2525, Fax +44 20 7387 2808)

6. Highways Economic Note No.1: 2001 – Department of the Environment, Transport and the Regions, UK. (Available from DETR publications, Tel +44 1709 891318, Fax +44 1709 881673)

7. School Travel, Strategies and Plans: A best practice guide for local authorities and Case studies report – DETR (UK) (Available from DETR Free literature, PO Box 236, Wetherby, LS23 7NB, Tel +44 870 1226236, Fax +44 870 1226237)

8. Various guides and publications are available from Sustrans – UK. PO Box 21, Bristol BS99 4HA, Tel +44 117 929 0888

9. Reducing Mobility Handicaps: Towards a Barrier-Free Environment – The Institution of Highways and Transportation – UK. (Available from IHT, 3 Lygon Place, Ebury Street, London SW1W 0JS, Tel +44 20 7387 2525, Fax +44 20 7387 2808)

10. The road to safety: Government Strategy for Road safety 1998–2002 "Fourth Progress Report, High Level Group on Road Safety" – Department of Transport. (now available from Road Safety and Traffic Division, Department of Transport, Findlater House, Dublin 1. Tel 01 8882330, Website www.transport.ie)

b

section b Consultation and Monitoring

3

chapter 3 Consultation

3.1 Why is it necessary to consult?

Consultation on traffic management schemes is important in informing and seeking views from people who are affected by a proposal.

Consultation can be split into a number of areas:

- With **fellow professionals** who may have an input into the scheme or whose service may be affected by it e.g. emergency services, healthcare establishments, other local authorities, planners, architects and park supervisors etc.
- With **politicians** who may act as a guide to public opinion on issues and may be involved in the decision making process.
- With **members of the public** who are affected by a proposal.
- With **specific groups** who are affected by a proposal such as residents' groups, cycling groups etc.

Some of these consultations are statutory requirements (see Chapter 3.2).

Public consultation is becoming of increasing importance, as many more people are demanding a say in proposals that affect them.

There are many reasons for and benefits to consultation. The main ones are listed in Tables 3.1 and 3.2. It is important that professionals in charge of projects remember that they are spending public money and that other people (from the groups identified above) should be involved in developing a scheme. Consultation will certainly help to minimise the risks of a mistake being made and having to make expensive changes to a scheme or being subjected to criticism in the media.

It is the role of the Road Authority to ensure that the objectives of a scheme are met and that an effective solution is provided.

Table 3.1 Reasons to consult
– Spending public money – Statutory requirement for certain schemes – To identify problems – To inform people – To seek feedback on ideas – To identify amendments and compromise – To gain local support – To demonstrate local democracy

Table 3.2 Benefits of consultation
– Results in a more acceptable local solution – Helps avoid expensive changes and potential complaints – Educates public expectation of what can be achieved within the roads authorities' constraints – Encourages community involvement – Creates ownership of the scheme – Helps to demonstrate a 'Best Value' approach – Helps to make best use of resources

3.2 Statutory consultations

The statutory requirements for consultation vary with the type of scheme being considered. The specific requirements and procedures for each subject area will be outlined in the individual chapters of this manual. General procedures and legislation will be outlined in this chapter.

Environmental Impact Statements for Road Schemes

Under Section 50 of Roads Act, 1993,
Part 5 of Roads Regulations, 1994 (S.I. No. 119 of 1994), and Article 14(a) of the European Communities (EIA) (Amendment) Regulations, 1999 (S.I. No. 93 of 1999, an Environmental Impact Statement (EIS) must be prepared when constructing a new road or widening/realigning an existing road where it is a:

- Motorway
- Busway
- new or widened road of 4 or more lanes which would be 8km or more in a rural area or 0.5km or more in an urban area
- new bridge or tunnel which would be 100 metres or more in length
- road development which would be likely to have significant effects on the environment

The EIS is submitted to an Bord Pleanala for approval and that body makes a determination on the proposed scheme in due course.

Part 8 procedure of the Planning and Development Regulations, 2001

Section 179 of the Planning and Development Act, 2000 sets out a framework under which a local authority must operate in respect to its own development works within its functional area. Detailed requirements for such works are contained in Part 8 of the Planning and Development Regulations, 2001 (S.I. No. 600 of 2001).

Under the 2000 Act and 2001 Regulations, a Part 8 procedure is required when constructing a new road or widening/realigning an existing road where a scheme does not require an EIS but where it is:

- 100 metres or more in an urban area
- 1km or more in a rural area
- a new bridge or tunnel

Works specifically excluded from this statutory procedure are:

- maintenance works and repairs
- emergency situations
- works required by statute or order of a court
- development in respect of which an EIS is required

Traffic Calming

Section 38 of the Road Traffic Act, 1994 empowers road authorities, in the interests of the safety and convenience of road users and subject to certain requirements, to provide traffic calming measures on public roads.

It defines traffic calming measures as:
measures which restrict or control the speed or movement of, or which prevent, restrict or control access to a public road or roads by mechanically propelled vehicles (whether generally or of a particular class) and measures which facilitate the safe use of public roads by different classes of traffic (including pedestrians and cyclists) and includes the provision of traffic signs, road markings, bollards, posts, poles, chicanes, rumble areas, raised, lowered or modified road surfaces, ramps, speed cushions, speed tables or other similar works or devices, islands or central reservations, roundabouts, modified junctions, works to reduce or modify the width of the roadway and landscaping, planting or other similar works.

It should be noted that additional procedures must be followed for traffic calming measures which are prescribed by the Minister (see sub-section 3 of Section 38 of the 1994 Road Traffic Act). To date, **no traffic calming measures have been prescribed by the Minister** so these specific procedures are not required. However where traffic calming measures are significant it is prudent for the road authority to consult with affected parties. Appropriate consultation procedures should also be considered for the provision of bus lanes and cycle tracks. Some road authorities use the procedures set out in Part 8 of the Planning and Development Regulations, 2001 for these purposes while other authorities use informal local procedures.

If traffic calming measures include the provision of regulatory signs, then the normal requirement of consulting the Garda Commissioner in respect of such signs, must be followed.

Traffic calming measures on a national road shall not be provided or removed without the prior consent of the National Roads Authority. See also Chapter 6.2

3.3 Who to consult

In addition to any statutory requirements, individuals and organisations should be consulted for a variety of reasons. Some will need to know details of the temporary traffic arrangements for the scheme so that they can plan their service or access requirements accordingly. Others will need or want to provide input into the scheme's planning, design or delivery.

It is important to consult the right people or organisations. It is not intended that every organisation will be consulted for each scheme, only those directly affected by the scheme will need to be involved. The potential consultees are arranged in the following groups from which relevant people and organisations can be selected:

1. Councillors and TDs
2. Members of the Public
3. An Garda Siochana/Garda Commissioner
4. Fire Service
5. Ambulance Service
6. Public Transport Operators and users
7. Other groups and departments within the local authority
8. Businesses
9. Community Groups and Residents' Associations
10. Education establishments, hospitals, healthcare practices, day care facilities, nursing and residential care homes
11. Groups for the Mobility/Sensory impaired
12. Road user interest groups such as Cycling groups, Road Hauliers Association etc.
13. Relevant prescribed bodies such as the DTO, NRA and special interest bodies.

In addition to any statutory requirements it is recommended that groups 1 to 5 be consulted on all traffic management schemes. Group 6 should be consulted when the scheme affects a road with a scheduled bus service. Groups 7 to 13 should be consulted when they or their operations are directly affected.

If traffic calming measures include the provision of regulatory signs, then the normal requirement of consulting the Garda Commissioner in respect of such signs, must be followed.

3.4 What to consult on

In addition to any statutory requirements for consultation, schemes that are likely to be sensitive or controversial from the road users, residents or local businesses point of view should be subject to a consultation exercise. This should be undertaken at various stages of a scheme's development (see Chapter 3.5).

Typically such schemes would involve:

- significant changes to on-street/off-street parking
- restriction of access for residents, businesses, emergency services, public transport operators and mobility impaired or disabled people
- significant environmental impact such as increased noise, vibration, air quality, visual intrusion
- significant traffic diversion/delay
- traffic calming schemes (other than minor ones)
- safety schemes that affect vulnerable road users
- schemes in areas where traffic issues are known to be sensitive
- schemes involving a large area or a long construction period.

3.5 When to consult

There are up to four stages of a scheme's development at which public consultation may be required. Only the largest or most sensitive of schemes will require consultation to be undertaken at all stages. Most schemes will require consultation at only one or two stages. The four possible stages for consultation are outlined below.

1. Problem Identification

When a traffic or safety problem is first identified it is desirable to involve people or organisations in putting forward their views on both problems and potential solutions. This stage of consultation should be considered for:

- large area-wide traffic calming schemes
- schemes involving restriction of access
- parking schemes where spaces will be lost or where charges or time limits are being introduced in sensitive areas.

Consultation at this stage may also be desirable for other large or sensitive schemes.

2. Feasibility/Preliminary design

When the initial ideas about options for a scheme are produced it is desirable to get some feedback on people's views and choices. This can prevent the construction of a scheme that is unpopular (and may require costly subsequent alteration). Consultation at this stage should always be considered when there are options and a genuine choice is available.

3. Firm proposals/Detailed design

When detailed proposals are produced a consultation exercise can be carried out if required, often in association with statutory procedures.

4. Monitoring after completion of scheme

For schemes that may be unusual in nature or where there are conflicting views over the success of the scheme, it may be desirable to assess public satisfaction after the scheme has been completed. The consultation should not be carried out until traffic patterns have settled down.

Although not part of a formal consultation exercise, it is beneficial to notify people of progress on schemes that take longer than 3 to 6 months between consultation and the start of construction. This can be carried out in a variety of ways (see Chapter 3.6). Residents and affected businesses should also be notified immediately prior to commencement of the works so that they can make alternative arrangements for access etc. if required.

3.6 How to consult

Using the appropriate method of consultation is very important. It ensures that the message is conveyed or views sought in the most cost effective and easy to understand manner. The main criteria for determining the method to be used are firstly, who is to be consulted and secondly, at what stage of the scheme's development they are to be consulted. There are a wide variety of possible methods and these are indicated below.

It is the responsibility of the person planning the consultation to select the appropriate methods to use for each stage of their consultation. It is not necessary to employ all of the methods listed. The most important issue is that the message gets across to as much of the potential audience as possible and that a good response rate is achieved where views are being sought.

Letters and leaflets – A letter about the scheme is the most common method of communicating details that are relevant to various recipients. The information should always include the following:

- the purpose of the letter
- a plain language description of the scheme
- drawings that a member of the public can understand
- a contact name and phone number for enquiries
- any critical dates and a programme
- a date to reply by if appropriate
- information about why views are being sought and a postage paid reply postcard/leaflet if public views are being sought
- information about what stage the scheme is at and a statement to the effect that the consultee's views are important and will be taken into account
- an invitation to any exhibitions or meetings that have been organised together with relevant details of the event
- photographs/sketches to help explain technical items and details of locations where similar features have been built
- Leaflets should be used for medium/large scale schemes.

It is the responsibility of the person planning the consultation to select the appropriate methods to use for each stage of their consultation.

Press releases – Press releases should be prepared for all traffic management schemes except routine maintenance or works already included in the road works bulletin. These should be in a non-technical style and liaison should take place with the local authority's Press Office (if available).

Posters and signs – Posters and signs displayed at the roadside can be useful in attracting road users' and residents' attention. They are most commonly used to give advance notification of intended works or traffic diversions/delays. They can also be used to invite comment on proposals where the public's view is actively being sought.

Committee reports – Committee reports are generally prepared for Councillors to take decisions or be informed about progress on particular issues and schemes. For routine schemes they will be prepared only at the budget allocation and review of programme stages. For schemes where decisions are required on details of the scheme (such as traffic calming) there may be reports at key stages of the scheme's development.

Public exhibitions and meetings – Public exhibitions are generally held to get public input and views on proposals. These can be useful in helping to explain schemes to the public but the attendance at such events can be low. Exhibitions can be costly to undertake, when the cost of preparing the displays and staffing the exhibition is taken into account. Such exhibitions rarely attract a true cross-section of the community. Public exhibitions are generally reserved for larger schemes or ones of a more sensitive nature. Public meetings are generally held for similar reasons, but have the potential disadvantage that they can easily be dominated by a vociferous minority.

Interview surveys – Interview surveys (either by phone, at the door or in the street) can be a cost-effective method of getting a structured sample of views on a particular issue. It allows the collection of views from a range of age groups, road users, ethnic background etc. The interviewers can also be seen as independent from the scheme. The cost of these can be allowed for in the scheme budget and they are often cheaper than holding public exhibitions.

Meetings with residents, specific interest groups etc. – Residents' associations, community groups and specific road-user interest groups such as Irish Guide Dogs for the Blind and the National Council for the Blind, may be approached to act as a sounding board for community views. They may request a meeting to discuss aspects of a scheme. Involving them can help to avert potential criticism later in the development of a scheme.

Adverts/news items in local papers or on local radio – Advertisements or news items in local papers or on local radio can help to get a message to a wider audience. However it can be difficult to measure the number of people that read or listen and take in the details. Adverts and news items can also be used in conjunction with press releases and posters/signs.

School newsletters – School newsletters can be a very useful way of making parents of schoolchildren in an area aware of a proposal and getting them to take an active interest. Notification is usually required well in advance for such publications and it is important that the information with which the schools are supplied is easy to understand and is checked before the school issues the newsletter.

Working Groups, Focus Groups and Forums – These groups can be useful to take soundings on ideas or in areas where it is difficult to get a reasonable response rate to questionnaires. They can also provide useful local information on problems and solutions. Care needs to be taken to ensure that they are representative of the community and that they are not dominated by a small number of unrepresentative interest groups or individuals.

Citizens' Panel – Citizens' panels are useful where it is difficult to get a reasonable response rate on a proposal or where the proposal is complicated and needs time to explain the issues involved. It allows for a cross-section of people (usually 13) to be involved in considering conflicting views on very sensitive issues and make a recommendation. The views of the panel are held to be representative of the local community.

Newsletter – Many local authorities now have a newsletter, which is usually distributed widely. If a scheme is high profile and sensitive (perhaps representing one of the local authority's key policies) and a major consultation exercise is planned, it may be appropriate to have an item in the newsletter.

General – For most consultations with professional colleagues internally and externally, exchange of letters and plans is usually sufficient.

For straight-forward notification of road works, letters, plans and sign/posters are generally sufficient although frontagers may request a meeting to discuss any individual needs or concerns.

Choosing the best methods of consultation

All traffic management schemes which are likely to be sensitive or where there is a genuine choice of options should be subject to a public consultation exercise.

As a minimum, the following methods should be used.

- A letter with a drawing explaining a scheme should be sent out to all relevant parties. A postage paid reply card/questionnaire should be included if views are being sought or a choice of options is available. For medium and larger scale projects a leaflet should be used instead of a letter.
- Press releases and news items should be undertaken where appropriate.

When schemes are thought to be sensitive and public input is needed it is important to get a good level of response to the consultation exercise. Consideration may therefore need to be given to using a range of methods. Moving a scheme forward on a low level of response increases the risk of the scheme being unpopular when it is introduced.

For more sensitive schemes, public exhibitions or meetings should be considered and if these fail to attract sufficient feedback then interview surveys should be undertaken to get a representative view. Meetings with residents' associations, community groups and specific interest groups should also be undertaken. In areas where there are schools, the schools newsletter could be used.

For large-scale schemes in sensitive areas consideration should be given to using working groups, focus group, forums and a citizens' panel.

3.7 Planning a consultation exercise

When planning a consultation exercise it is important to have an assessment of how sensitive the issues or schemes being consulted on are likely to be. More sensitive schemes will generally need more careful and detailed consultation exercises. With limited staff resources and budgets for the work it is necessary to prioritise the level of consultation exercise which should be carried out. A small traffic calming scheme in a single residential road that has requested such measures is unlikely to be too sensitive. Hence a letter to each of the households and businesses explaining the schemes together with the information outlined in Chapter 3.6, will probably suffice. If the response is favourable then it is probably safe to proceed with a scheme. A large traffic calming scheme with a lot of measures or a parking restriction scheme is likely to be more sensitive. Hence it will need more care and planning; public exhibitions and meetings may be needed. Further advice on these issues is given in Chapter 3.6.

3.8 Using the results of a consultation exercise

When the results of the consultation exercise are available it is necessary to review them. The findings should be reviewed critically and a number of questions should be asked:

- Was the response favourable? – What is an acceptable percentage in favour (51%?, 67%?, 100%?)
- How many people from the area responded? – What is an acceptable response rate (10%?, 20%?, 50%?, 67%?, 100%?). If the response rate is low and it has been difficult to get people to take an interest, then it may be that the sample is unrepresentative. It may be necessary to undertake some direct interview surveys of people's views to check that the response is representative.
- Does anything else need to be done before proceeding to the next stage of the scheme design? – Have any changes to the scheme been suggested? Can these be accommodated within the scheme whilst still meeting the objectives or as a compromise? If the scheme was unfavourably received what is the next course of action?

It is not possible to have standard answers for each of these questions. Each case will have to be judged on its own merits.

If the response has been favourable (e.g. more than 67% in favour) and a good response rate has been achieved (e.g. 20% or more). Then it is probably safe to proceed with the scheme.

It is important to give consultees' feedback on the results of the consultation exercise. The links to groups created during the consultation process can be used to help with this.

3.9 References

1. Planning and Development Regulations, 2001 (S.I. No. 600 of 2001) (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

2. Road Traffic Act, 1994. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

3. Modern Local Government: Guidance on Enhancing Public Participation – DETR (UK) (Available from DETR Publications Sales Centre, Unit 8, Goldthorpe Industrial Estate, Goldthorpe, Rotheram S63 9BL, Tel +44 1709 891318, Fax +44 1709 881673)

4. Procedure for Consultation on Traffic Schemes – Luton Borough Council (UK) (Available from Luton Borough Council, Tel +44 158 546962, Fax +44 1582 546649)

5. Feet First: Public attitudes and consultation in traffic calming schemes – Transport 2000 – UK. (Available from Transport 2000 Trust, Walkeden House, 10 Melton Street, London NW1 2EJ, Tel +44 20 7388 8386).

Contacts

1. Senior Orientation and Mobility Instructor, Irish Guide Dogs for the Blind,Model Farm Road, Cork. Tel: 1850 506 300 Email: igda@iol.ie

2. Access Adviser,National Council for the Blind of Ireland, Whitworth Road, Drumcondra, Dublin 9. Tel: 01 830 7033 Email: heather.hunter@ncbi.ie

4

chapter 4 Monitoring

4.1 The need for monitoring

The principal objective of those involved in traffic management is the organisation of the safe and efficient movement of people and goods. At many stages during the planning, design, implementation and operation of transport facilities, it is necessary to carry out a check on progress towards a particular goal or target. This can apply to all types of transport schemes from small traffic management schemes to new road schemes and major transport projects such as LRT. The monitoring process is a tool for assessing progress and whether further action is required.

4.2 Scope of monitoring

Monitoring can take place on the progress of an individual scheme, a group of schemes, a particular travel mode (for example cycling), or towards a particular goal such as reducing accidents.

The process of monitoring can be applied to a number of areas of traffic management schemes:

- **Project management** involves the monitoring of the physical and financial progress of a scheme against a programme and budget
- **Monitoring** of transport trends (car usage for example)
- **"Before and After"** studies to assess the effectiveness or success of a particular measure or project

Monitoring can provide useful information at review points within the process of planning, design, implementation and operation of the transport system.

Project management is concerned primarily with the delivery of schemes to an agreed timetable and budget. Each project or client organisation involved with the project will have its own procedures for undertaking this work. A weekly or monthly review of progress and costs incurred should be undertaken. If progress falls behind the agreed timetable and this cannot be made up later in the project then the client should be notified. Similarly if the costs incurred mean that the scheme cost is likely to exceed its estimated (or tender) value by a specified amount (see 4.3) then the client should be notified.

There are occasions when circumstances beyond the control of the project manager can affect the progress or costs of schemes significantly. Each organisation will have its own procedures for dealing with such eventualities. It is important that such problems are identified as early as possible in order that early action to correct the situation can be taken.

Monitoring of transport trends is usually carried out by survey. Some of the common surveys associated with travel and movement that assist in monitoring are listed below:

- vehicle passage counts
- vehicle turning movement counts
- origin and destination surveys
- bus and car occupancy surveys
- pedestrian counts
- cycle counts
- speed surveys
- parking surveys
- noise and emission surveys

The transportation engineer is also interested in operational characteristics of the network such as:

- road accident details and locations
- locations where congestion regularly occurs including queue lengths and delays
- road condition surveys (including skidding resistance)
- inspections of the condition of street furniture such as safety fence, road signs and markings

- street lighting levels
- traffic signal operation
- variable message sign (VMS) operation

It is important to consider external factors. The monitoring of weather conditions plays an essential part in planning winter maintenance schedules, and population data plays an important part in calculating certain types of accident rates.

4.3 Setting objectives

There are two distinct objectives of the monitoring process.

The first objective is to determine whether any intervention is necessary by observing progress on a project or the operational characteristics of the transport system (such as accidents or congestion spots), on a regular basis. This can be termed routine monitoring or trend analysis. It is usual to define some criteria, which would trigger investigation or corrective action.

For the project management of schemes it is possible to set both progress (in time) and financial criteria which trigger the consideration of some form of corrective action. With scheme progress, critical path analysis of the design or works programme can be undertaken to determine the effects on the project of certain events or activities being delayed. If activities on the critical path are delayed then the scheme will be delayed and corrective action may be necessary. In financial terms if extra costs are incurred and the scheme cost is likely to exceed its estimated (or tender) value by a specified amount (sometimes 5% to 10%) then the client should be notified.

Transport trends are generally reviewed over a longer period of time, annually or every few years, unless it is important to have information about particular times of the year such as seasonal information.

The second objective is to make an assessment of whether any change has occurred after some form of action has taken place. This is often termed a "Before and After" study. An example of this would be comparing various traffic effects before and after introduction of traffic calming in a residential area. Transportation engineers would be keen to assess any change in motor vehicle speed and volume, and to determine whether traffic had transferred to adjacent areas, or whether modal change had occurred. They may also wish to measure changes in traffic noise and kerbside emissions. The effect of the scheme on road accidents will also be of interest.

4.4 Principles of monitoring

Monitoring techniques should be objective and should be applied consistently.

Routine monitoring requires the development of criteria so that intervention levels can be determined. Road authorities can determine, for example, the number of road accidents occurring at a single site in a three-year period that warrants further investigation.

The purpose of such criteria is to assist in the allocation of scarce resources within areas of work or funding. It is therefore helpful to have the criteria ratified by local politicians so that an attempt to divert resources towards unjustified schemes can be resisted.

Monitoring techniques can assist in measuring the performance of schemes.

4.5 Evaluation

When the results of a monitoring exercise are available it is customary to compare these with performance indicators or targets. This allows an evaluation of how a particular scheme has performed against the required standards and an assessment as to whether any further action is required to improve the performance of the scheme. These are also useful indicators of whether the scheme offers value for money.

Monitoring techniques can involve some form of statistical or economic analysis to assist in measuring the performance of schemes.

The most common form of statistical test used in before and after studies (for accident analysis) is the Chi Squared test, which provides the assessor with a level of confidence in whether the change that has occurred is due to the intervention rather than due to random fluctuation.

Economic achievement is usually measured by one of two assessment procedures, First Year Rate of Return (FYRR), or Net Present Value (NPV).

FYRR provides a rough and ready assessment of benefit in relation to cost, and is expressed as a percentage. NPV looks at the whole life of the scheme, and allows the assessor to evaluate costs and benefits beyond year 1, and to discount them back to a present day value.

More detailed information on statistical techniques is detailed in Appendix 2 of "A Guide to Road Safety Engineering in Ireland".[1]

4.6 References

1. A Guide to Road Safety Engineering in Ireland – Department of the Environment. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

C

section c Speed Management and Traffic Calming

5

chapter 5 Speed Management

5.1 The speed problem

Speeding is one the biggest road safety challenges to be tackled.

Excessive or inappropriate speed is also one of the most common public complaints about the adverse effects of traffic. **Inappropriate speed** means driving at a speed that is too fast for the type of road or prevailing circumstances, regardless of the posted speed limit. Driving outside a school at 30mph when children are entering or leaving school is an example of this. **Excessive speed** means driving at a speed that is in excess of the prevailing speed limit.

Excessive speed is a major contributory factor in up to one-third of all road accidents in the UK.[1] Reducing speed to more appropriate levels can produce substantial reductions in both the number and severity of road accidents. A study of traffic calming schemes in the UK showed that they had reduced mean speeds by 10mph and reduced accidents by 60%, with few serious injuries occurring.

Research[2],13 has shown that for a 1mph reduction in mean speed, a reduction in accidents of between 3% and 6% could be expected, depending on the type of road.

Diagram 5.1 below illustrates the relationship between speed and stopping distance. When drivers observe a potential hazard such as a pedestrian on the road or a car pulling out of a junction, they will brake and their vehicle will come to a stop. The distance that the vehicle travels during this period (stopping distance) is made up of two components:

1. The distance travelled while the driver reacts to the potential hazard
2. The braking distance for the vehicle and driver

The stopping distances shown in Diagram 5.1 are from the figures given in "Rules of the Road",[3] at different speeds of travel for an alert driver with a good car, good brakes on a dry road surface. These distances increase significantly on a wet, smooth road surface.

Diagram 5.1 Speed and Stopping Distance

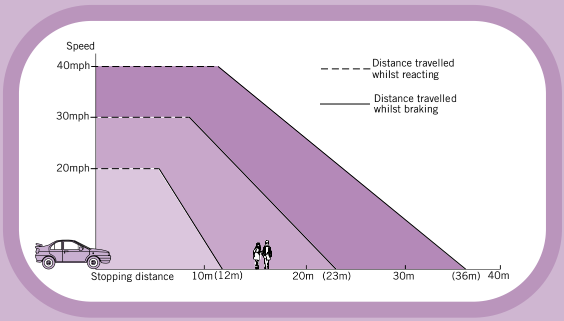


Diagram 5.2 Speed Kills

The faster a vehicle is being driven when it hits a pedestrian or another vehicle, the more likely it is to cause serious or fatal injuries. Table 5.1 indicates the risk of a pedestrian being killed or seriously injured when hit by a car travelling at various speeds. The risk of a pedestrian being killed when hit by a car travelling at 30mph rather than 20mph increases by nine times (from 5% to 45%) and nearly doubles again for a car travelling at 40mph. It can be seen clearly that the risk of death and injury decreases markedly as speeds reduce.

The risk of serious injury to a car occupant (wearing a seat belt) in a collision with either an oncoming car travelling at the same speed or a stationary rigid object is shown in Table 5.2. This increases by three times (from 16% to 48%) for a car travelling at 30mph rather than 20mph. This nearly doubles again for a car travelling at 40mph.

Exceeding a safe speed has been identified as a contributory factor in 27% of fatal accidents and 15% of injury accidents in Ireland.[4]

From this information it is quite clear that reducing vehicle speeds can bring about a major reduction in both the number of road accidents and the severity of injuries. There are major benefits to be gained from reducing speed in residential areas and other sensitive areas where many accidents relate to vehicle speeds.

5.2 Attitudes to speed

Concerns about the adverse effects of vehicle speed are usually expressed as concern over one or more of the issues outlined in Table 5.3.

These concerns will often lead to pressure for unrealistic speed limits, traffic calming measures, speed cameras or greater levels of Garda enforcement.

Despite the fact that people express concern about the speeds at which vehicles are driven or ridden, many of the same people will drive too fast themselves at times.

Table 5.1 Percentages of Pedestrians killed and injured when hit by a car at various speeds

Speed of car	Percentages of pedestrians killed
40mph	85
30mph	45 (and many seriously injured)
20mph	5 (few seriously injured, 30% no injury)

Table 5.2 Probability of serious injury to a car occupant

Speed of car	Percentage probability of serious injury
40mph	80
30mph	48
20mph	16

Many different excuses are offered in respect of speeding:
"I was late for work"
"It was late and there was nobody about"
"I was just keeping up with traffic"
"I didn't see the signs"
"Everyone does it"
... but they are just excuses!

Many people have high expectations of the level of speed reduction that can be achieved in practice. They perceive other drivers to be the problem without being conscious of the way that their own behaviour contributes to the problem. Table 5.4 shows the results of NRA speed surveys (freeflow) in 1999[5,6]. Many drivers exceed speed limits in freeflow conditions.

5.3 Influencing driver and rider behaviour through Speed Management

The speed at which a driver or rider chooses to travel along any given section of road is influenced by many factors. These factors can be considered in five broad areas as shown in Table 5.5.

One of the main variables in this decision making process is an individual's own attitude to speed. Although this is influenced by many of the factors listed in Table 5.5, it is evident that a fundamental change in drivers' attitude to their own speed is necessary if speeding is to be brought under control. In order to bring this about, to effectively manage speed, it is necessary to take action over a wide range of areas relating to the factors in Table 5.5:

- education training and publicity for drivers and riders
- setting appropriate speed limits
- improving enforcement
- road design and traffic calming
- technology

Action in each of these areas needs to be co-ordinated by roads authorities under a "Speed Management Strategy". Such strategies are becoming more common in the UK and involve the

Table 5.3 Typical concerns about the adverse effects of vehicle speeds

- Accidents, danger and anxiety
- Vulnerable road users (pedestrians, cyclists etc.)
- Severance of communities
- Noise
- Vibration
- Vehicle emissions/air quality

Table 5.4 Percentage of drivers exceeding speed limits

Speed Limit	Percentage of drivers exceeding the speed limit in freeflow conditions
30mph (urban arterial)	99%
30mph (urban residential)	68%
40mph (urban arterial)	67%
40mph (urban residential)	10%
60mph (national primary)	51%
70mph (motorway)	29%

Accident Scene

co-ordination of action of a number of bodies including Police, Health Authorities, Planning and Roads' Authorities.

The production of a speed management policy and plan can facilitate a comprehensive approach to tackling the problem rather than a piece-meal one. Devon County Council's Speed Management Strategy[7] is a good example of this co-ordinated approach. It addresses community concerns about speed as well as speed related accidents.

5.4 Education, Training and Publicity

Education, training and publicity approaches to tackling speeding problems consist of a wide range of measures. A number of initiatives that could be included in a Speed Management Strategy are indicated below.

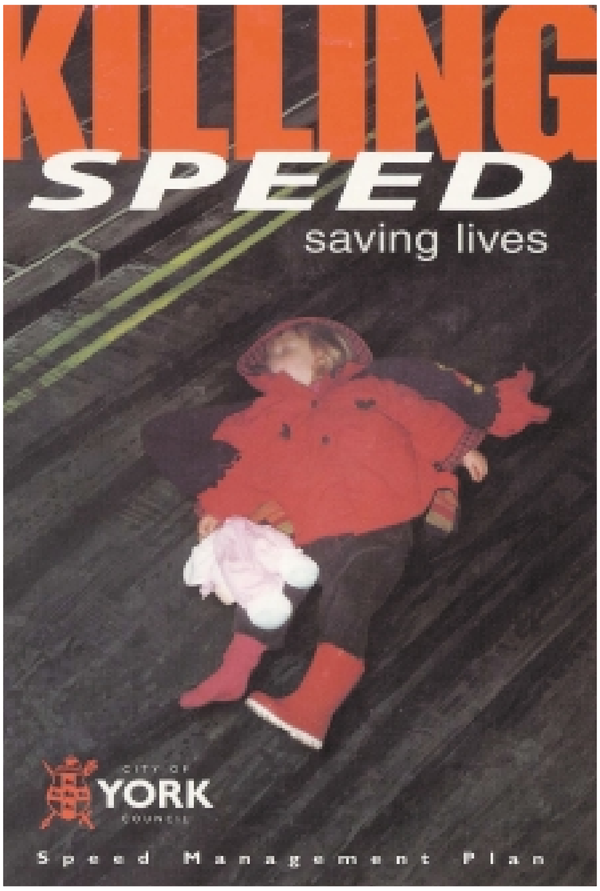
Hard hitting national and local publicity campaigns on the effects of speeding can educate people about the implications of speeding and change social attitudes to speeding so that it is considered unacceptable. This will help to bring about a long-term change in public attitudes to speeding.

Schoolchildren can be educated about the problems that speeding causes through project work (for younger children) and workshops/theatre (for older children). There is an opportunity to bring project work into the public consultation phase of traffic calming schemes in local areas near schools. Prizes can be offered for the best slogans or work. This helps to get over the message about the dangers of speeding at an early age and helps to get the message through to parents.

Drivers and riders can be trained beyond the basic levels required for the driving test. It is recognised that younger and inexperienced drivers are often at a higher risk of being involved in, or causing an accident. They tend to overestimate their driving abilities and are not equipped to see potential road safety hazards as they arise. Although they may have quick reactions they can have insufficient time and skills to take avoiding action. There is a potentially lethal combination of speed and inexperience. Many UK local authorities now run "Driver

Table 5.5 Main factors affecting drivers and riders choice of speeds

- Road layout factors such as width, gradient, alignment, surroundings, surface quality, speed cameras, signs and road marking
- Traffic factors such as volume, composition (%age HGV etc.) and prevailing speed
- Environment factors such as weather, road surface condition (dry, wet etc.) and light conditions (sun, street lighting etc.)
- Vehicle factors such as type of vehicle, performance (acceleration, handling) comfort levels (noise insulation) and safety features
- Driver/rider factors such as age, experience, attitude, passenger accompaniment, drink/drug impairment, speed limit and perceived level of enforcement



Speed Campaign

Improvement Schemes", which are self-funding. This type of scheme offers some drivers who have committed less serious offences an alternative to paying a fine and receiving penalty points on their licence. Instead they can pay for a place on an approved Driver Improvement Scheme run jointly by the local authority, police force and driving instructors. These are aimed at rehabilitating drivers and instilling a more responsible attitude to issues such as speed. If drivers do not complete the scheme satisfactorily then they are sent back to the Courts for sentencing. Such schemes are very successful and have very low re-offending rates.

Speed Limit

5.5 Speed Limits

Speed limits indicate the maximum speed at which vehicles are permitted to travel on a length of road. They are not an indication of the speed at which all vehicles can travel safely at all times and in all conditions.

Article 7 of S.I. No. 182 of 1997 – Road Traffic (Traffic and Parking) Regulations, 1997[8] states that "A vehicle shall not be driven at a speed exceeding that which will enable its driver to bring it to a halt within the distance which the driver can see to be clear".

Speed limits indicate the maximum speed at which vehicles are permitted to travel on a length of road. They are not an indication of the speed at which all vehicles can travel safely at all times and in all conditions.

The effectiveness of speed limits

The introduction of a speed limit will not necessarily have a significant impact on the speed of vehicles along a particular length of road. Many politicians and members of the public call for the introduction of lower speed limits on roads as a result of concerns about speeding, in the hope that this will bring down speeds significantly.

The research evidence however shows that there is little evidence to substantiate this hope. In studies[2,9] the introduction of a 30mph speed limit in place of a 40mph limit was shown to reduce the 85 percentile vehicle speeds by around 3mph. Similarly the introduction of a 20mph speed limit (without traffic calming measures) in place of a 30mph speed limit reduced 85 percentile vehicle speeds by around 1.5mph.

The introduction of unrealistic limits also gives An Garda Siochana enforcement problems. Drivers may not accept the need for the reduced speed limit and may complain that they have been treated unfairly when caught. It is important that speed limits are set in a realistic way and that they can be enforced efficiently and effectively. The ineffectiveness of unrealistic speed limits and their enforcement problems should be communicated more widely so that the expectations of the public and politicians are more realistic.

Some local authorities in the UK have a policy of only introducing new 20mph and 30mph speed limits where the road layout restricts the speeds of most vehicles to this or where traffic calming measures or speed cameras are being introduced. This policy is designed to improve the effectiveness of the speed limit.

Speed limits in Ireland in 2003

The general speed limit is 60mph, whilst the motorway speed limit is 70mph.

The normal speed limit for a built-up area is 30mph and road authorities may introduce special speed limits of 40mph and 50mph on appropriate sections of road.

The main purpose of built-up area or special speed limits is to provide for situations where the general speed limit is inappropriate. In urban areas the emphasis may be more on assessing when the general speed limit and 40mph speed limits should be reduced to 30mph. In many other European countries there is an option for a 30kph or 20mph (UK) speed limit, mainly on residential roads. There are also lower speed limits in some mainland European countries, these are often referred to as "Home Zones" and the speed limit is 15kph, falling to walking pace when there are pedestrians around.

Legislation in Ireland does not currently allow for speed limits lower than 30mph. However, this does not mean that new roads in residential areas and in the centres of villages, towns and cities cannot be designed for lower speeds such as 20mph (see Chapters 1.7 and 7.1). Designing for these lower speeds in appropriate areas can produce safe, attractive places to live.

Methods for assessing and setting appropriate speed limits

A method for assessing and setting appropriate speed limits for different types of roads (in England and Wales) is detailed in Circular Roads 1/93.[11] This sets out a number of general principles for the use of speed limits of 30mph and greater, together with an assessment procedure for setting appropriate speed limits. Guidance on the provision of 20mph speed limits is given in Circular 5/99.[12]

General principles for the introduction of speed limits

1. Local speed limits are not normally necessary where the character of the road limits the speed of most vehicles (around 95%) to a level at or below the limit under consideration.
2. The accident record of the length of road should be examined and taken into account when considering the introduction of a speed limit. However it may be the case that the accident problem can be treated without a speed limit.
3. Mandatory speed limits should not be used to solve the problems of isolated hazards such as a junction or bend. Measures such as signs or other improvements may be more appropriate. Similarly, the provision of footpaths is a more effective way of improving pedestrian safety than a speed limit.
4. Speed limits should only be lowered when a consequent reduction in vehicle speeds can be achieved. Supporting engineering measures and more rigorous enforcement may be needed to help reduce actual vehicle speeds.

5. The most important factor in setting a speed limit is what the road looks like to the road user. This is influenced by many factors (see Table 5.5). Road users will expect lower limits where there are more potential hazards such as schools, pedestrian activity, frontage development etc.

Procedure for evaluating speed limits

The procedure for evaluating whether a particular speed limit is appropriate for a length of road involves an assessment of:

- the nature of the road and the traffic using it (see Table 5.6)
- the accident history for the road and whether the speed limit and any associated measures are likely to help to reduce the problems
- the 85%ile speed of traffic travelling along the road. This should be no more than 7mph or 20% higher than the proposed limit unless it is intended to introduce associated speed reduction measures.

TABLE 5.6 SPEED LIMIT ASSESSMENT TABLE NATURE OF ROAD AND TRAFFIC

Character of Environment	Character of Road	Nature of Traffic
30mph Speed Limit Built-up with development in depth on both sides of the road. Properties with individual access to the road including schools, factories and recreation grounds. Partially built up lengths lying between 30mph limits and not long enough to stand on their own as 40mph limits.	i) City/town streets and unimproved main traffic routes, or ii) Main roads through villages with Frequent junctions, inadequate visibility for speeds much above 30mph and pedestrian crossings. Few parking and waiting restrictions.	High proportion of two wheeled vehicles. Large number of pedestrians.
40mph Limits Built-up (as above)	Main traffic routes (e.g. ring and radial routes) with good width and layout. Adequate footways and crossing places where necessary. Parking and waiting restrictions.	As above
Partially built-up (usually exceeding 50% of frontages). Buildings generally set back from road, sometimes with service roads. Undeveloped lengths between 30 and/or 40mph limits and too short for a higher limit.	By-passes and other important traffic routes which have become partially developed	A noticeable presence of two wheeled vehicles and pedestrians.
50mph Limits Lightly built-up. Some frontage development. Rural roads. Development not essential but maybe cafes or filling stations or other features which attract traffic. e.g. parks and sports grounds	Suburban roads or high standard roads on the outskirts of urban areas. Roads with restricted visibility or junctions or, where dual, gaps in the central reservation. By passes which have become subject to some development.	Few pedestrians (or full provision for crossing by means of subways or bridges. Few pedal cyclists (or road provided with cycle tracks).

Measures to reduce vehicle speeds are outlined in Chapter 6 and subsequent sections of this chapter.

These factors together with the views of An Garda Siochana on the practicalities of enforcement should be considered before deciding on whether or not to proceed with a speed limit proposal.

Consultation

Under the Road Traffic Act, 1994 county councils are empowered to make bye-laws to apply speed limits in respect of roads in their area. This includes roads within borough councils and town councils. There must be full consultation with the sub-county authorities in respect of speed limits for the roads in those areas. County councils must also fully consult with the Garda Commissioner.

City councils are also empowered to make bye-laws to apply speed limits in respect of roads in their area. They must fully consult with the Garda Commissioner.

County and City Councils proposing to introduce speed limits must notify the bodies mentioned above regarding the proposals and consider any written representations received within the period (not less than one month after the date of service of the notice) specified in the notice.

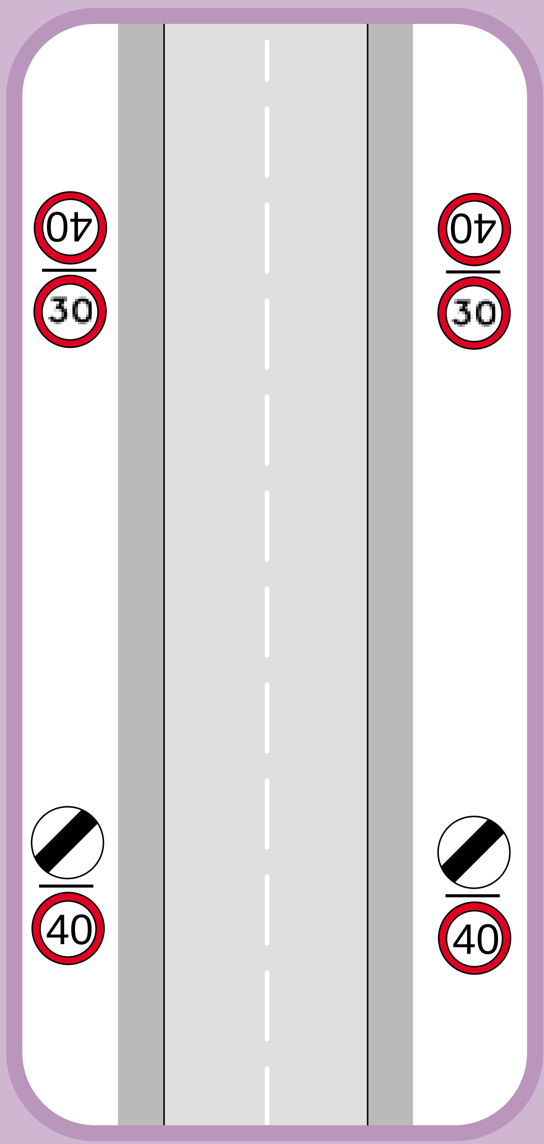
The prior consent of the National Roads Authority is required for any speed limit on a national road.

Speed limit signs must not be erected without the introduction of supporting bye-laws.

Villages – In the case of villages with high traffic levels, a speed limit may be sought to protect village life and a more lenient interpretation of the criteria may be justified. The views of An Garda Siochana on the practicalities of enforcement should be sought and taken into account. It may be that appropriate traffic calming measures will help to reduce speeds.

Length of speed limits – The minimum length of a speed limit is normally 800 metres. This is to give drivers the opportunity to adjust their speeds and not confuse them with frequent changes of limits. Situations arise where it is better to curtail or extend a

Diagram 5.3 Buffer Zone



speed limit to clear a hazard such as a bend, a junction or a hump-backed bridge. The signs for the limit need to be located in a position where they can be clearly seen.

Buffer zones – A buffer zone is a short length (800 metres minimum) of speed limit such as 40mph on the outskirts of an urban area. The introduction of a 40mph speed limit between the general limit (60mph) and the built-up area limit (30mph) can help drivers to adjust their speed incrementally.

5.6 Enforcement initiatives

A significant number of drivers will only reduce their speed if they believe that they stand a realistic chance of being caught and prosecuted. This perception would deter these drivers from speeding. However, many drivers' expectation is that the chance of being caught on most roads is comparatively small. In order to achieve and maintain an effective deterrent to speeding, more priority needs to be given to this area of enforcement.

It is unrealistic to expect constant attention from An Garda Siochana to the many thousands of miles of speed limits that are in place. The many speed checks and traps that are carried out are often determined on the basis of local complaint. Consideration should also be given to targeting lengths of road with high speed-related accident rates. This criterion is used by many UK police forces to determine priorities for enforcing speed limits.

Most traditional methods of speed enforcement such as radar and laser speed measurement devices and following speeding vehicles involve intensive use of uniformed officers, which is very costly. A more cost-effective way of enforcement is the use of speed cameras.

Speed cameras

Speed cameras now offer a more efficient solution for targeting speeding problems at particular locations or along lengths of roads. There are a variety of systems on the market all consisting of special cameras allied to an automatic detection device.

Speed Camera site

The many speed checks and traps that are carried out are often determined on the basis of local complaint. Consideration should also be given to targeting lengths of road with high speed-related accident rates.

The images of speeding vehicles are recorded on either 35mm film, digital information disks or video. With the 35mm film and digital systems, two photographs are taken (0.9 of a second apart) for each offence. The video system records vehicles continuously. Detection systems consist of radar, laser or piezometric tubes (either on the surface or buried in the road).

The camera is only triggered by the detection system if vehicles exceed a threshold speed, which can be set by the operator. The cameras can be used at fixed sites or in a mobile fashion at the roadside or mounted inside unmarked Garda vehicles.
Fixed sites are conspicuous and act as a highly visible deterrent to speeders. They can be left to operate on their own (minimising resource requirements) and one camera can be moved around several sites in rotation. Mobile systems are not as conspicuous but are more flexible and offer cheaper initial installation costs than fixed camera sites.

Effectiveness and justification of speed cameras

It is recognised that many drivers slow down in the vicinity of camera sites and then speed up again once they have passed them. However, before and after studies have shown that they still produce significant benefits. Experience in the UK suggests that speed cameras can reduce 85%ile vehicle speeds to within around 5mph of the speed limit. Hence, unless the actual 85% speeds of vehicles are around 10mph or more above the speed limit, they are unlikely to have a significant effect. Speed cameras can reduce accidents by around 20% to 33%, if the accidents are related to speed. By comparison traffic calming can reduce accidents by around 60%. Speed cameras offer the advantage that they can be used on busier roads, which are not suitable for traffic calming.

Speed cameras are expensive to buy and run. In the UK, road authorities often purchase the cameras and install any necessary roadside equipment. The Police then maintain and operate the equipment.

The economic case for the use of speed cameras was examined in detail in an UK Home Office report.13 This report examined the use of camera technology for enforcement in ten police force areas and concluded that speed cameras had:

- reduced accidents by an average of 28% at speed camera sites
- released traffic officers for other duties
- helped in the detection of other crimes such as stolen vehicles and provided information for criminal intelligence units
- paid for themselves five times over in the first year (based on savings in the cost of accidents)

Signing for speed camera sites and routes

It is important to erect signs warning drivers of the use of speed cameras along a particular route. This improves the deterrent effect of the cameras and helps to reduce speeds. The main purpose of speed management is to prevent speeding not to catch people speeding. Creating a public perception that there is a high chance of being caught if drivers and riders speed is crucial in deterring them from speeding. The right balance between prosecution and deterrence needs to be struck if the public are to support the introduction of these measures. Markings on the carriageway are provided at many fixed camera sites, to provide a secondary check of vehicle speeds (see Picture 5.4). These also act as further deterrents to drivers.

Selection of sites for enforcement

When selecting sites for speed enforcement activity it is important to take into account the accident record for the location or length of road. It is recommended that road authorities and An Garda Siochana discuss the locations where speed enforcement is likely to produce the biggest savings in accidents related to speeding. This should be based on a speed survey and accident information. It is possible to agree a schedule for the frequency of enforcement activity relating to the number of accidents and other factors.

5.7 Road design and traffic calming

Although many roads are subject to speed limits, the speed of many vehicles using them will be greater than this limit or the design speed for the roads.
The way in which roads are designed and laid out has a major influence on the speed at which traffic will use them. It is recognised that wider straighter roads encourage faster speeds. While this is appropriate for certain roads such as motorways and national roads with little or no frontage access, it is inappropriate for many other roads. Historically road design has concentrated on reducing delays and improving journey times. Although there is a hierarchy of design speeds, it has generally been used as a minimum standard of design. The issue of constraining vehicle speeds to a maximum design speed is a very recent one. It has generally only been applied in new residential areas or in sensitive parts of villages, towns and cities.

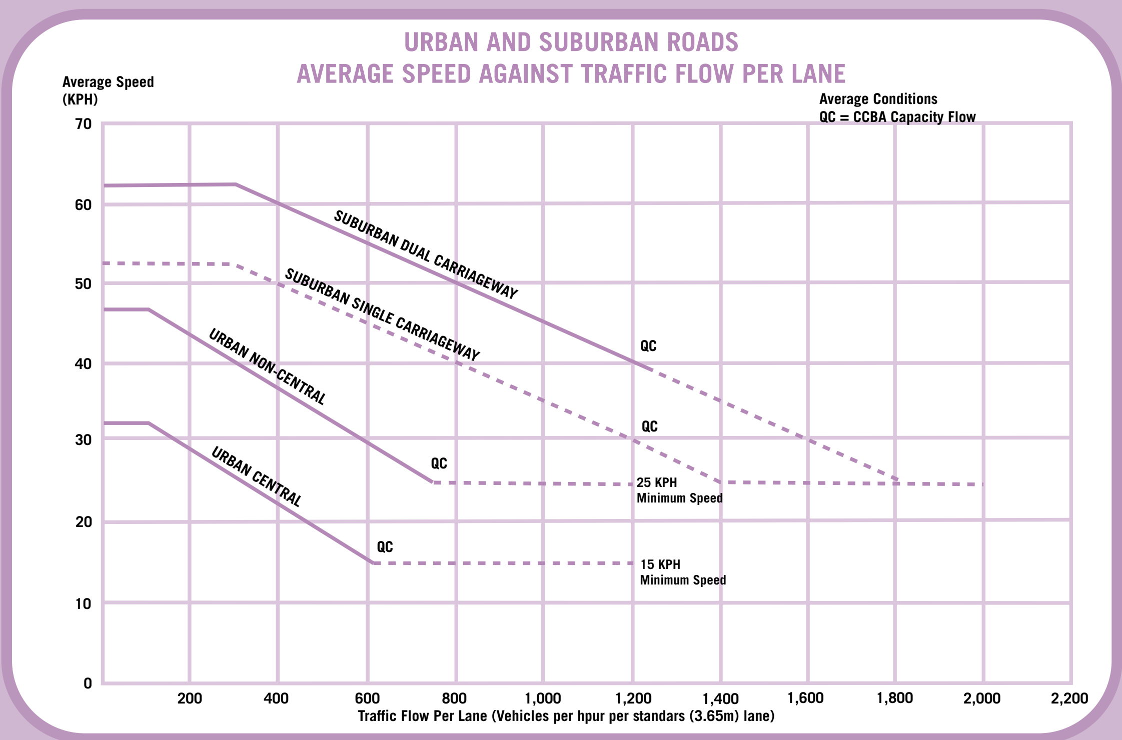
The width and layout of a road in terms of how the carriageway is marked out also affects speed. Speeds on a section of single carriageway with central hatching and islands would be significantly lower than an identical road without such features. The degree to which the surrounding buildings and trees/bushes enclose the road affects speeds.

Traffic calming and other forms of speed reduction measures such as speed limits and speed cameras are necessary because of the way in which drivers use the road network. Design practice needs to address maximum standards as well as minimum standards for design speeds if the safety record of roads is to improve and the need for expensive remedial treatments is to be avoided.

Reduced speeds on urban roads can actually result in increased traffic flow per lane as shown in Table 5.7.

Traffic calming techniques are dealt with in detail in Chapters 6 and 7.

Table 5.7 Speed/Flow Graph



5.8 Technology initiatives

Technology can be used to assist in reducing the speeds of vehicles. A variety of trials and research projects have resulted in the development of new approaches to treating speeding problems.

Signing

Signs that can display different messages or speed restrictions have been introduced in various locations in the UK.

Variable speed limits have also been introduced on a section of the M25 in the UK, to smooth traffic flows and reduce accidents in a heavily congested section of motorway. Another example of this is the use of variable speed limits outside schools, where a lower speed limit is applied when children are entering or leaving schools, than the normal one for that section of road.

Variable message signs can also be used to warn drivers of incidents ahead so that they can take appropriate action. Developments in this field are bringing about the capability to provide alternative route guidance and signing for major incidents.

It should be noted that there is no provision at present, in Ireland, for the use of variable speed limits.

The use of fibre optic signs that are blank for the majority of the time and only come on when triggered by the speed or presence of vehicles has increased in recent years. They have generally proved to be very effective at hazardous locations such as bends and junctions. They can be incorporated into Gateway schemes for towns and villages. Their special nature seems to produce greater awareness in drivers of a hazard and the need to slow down if appropriate. These signs have been shown to reduce speeds by up to 5mph.[12]

Number plate recognition

Number plate recognition systems have made great advances in recent years. These are systems that can automatically read number plates without any manual assistance. They can be linked to computer systems that can access details of the registered driver of the vehicle and could provide an automatic enforcement system. This technology has been used to display vehicle registration numbers at temporary speed limits on motorway roadworks in the UK to improve speed reduction by making the speeding message more personal to offending drivers and riders.

Traffic signals

Some European countries operate a system where if drivers approach a set of traffic signals too quickly then the lights automatically turn to red before they get there. These are often used at signal installations as vehicles enter a built-up area with a speed limit. Signs are displayed in advance of the junction warning drivers that the system is in operation.

Headway control

Trials have been conducted on systems that can adjust the speed of a vehicle automatically if the distance between the vehicle and the one in front reduces to less than a pre-determined minimum length. Concerns do exist however over safety issues with regard to control of the vehicle with such systems. The use of audible warnings instead of automatic speed control has also been tested but the study found that many drivers ignored them.

Variable Speed Limiters

Systems for the automatic control of a vehicle's maximum speed have been trialled. A device in the vehicle's management system receives signals from roadside transmitters or from Global Positioning Systems (GPS) combined with digital maps and the vehicle speed is automatically reduced. Sweden and the Netherlands are conducting large-scale trials of these systems.

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9. TRL Report 363: Urban speed management methods – Transport Research Laboratory – UK. Tel +44 1344 770783/84

10. Road Traffic Act, 1994. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

11. Circular Roads 1/93: Local Speed Limits – Department of Transport – UK. (Available from DETR, Great Minster House, Marsham Street, London, SW1P 4DR)

12. Circular Roads 5/99: 20 mph Speed Limits – Department of Environment, Transport and the Regions. (Available from DETR, Great Minster House, Marsham Street, London, SW1P 4DR)

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14. TRL Report 177, Traffic calming – Vehicle activated speed limit reminder signs – Transport research Laboratory – UK. Tel +44 1344 770783/84

15. New directions in Speed Management – A review of Policy – DETR – UK. (Available from DETR, PO Box 236, Wetherby, West Yorkshire, LS23 7NB – Tel +44 870 1226 236 Fax +44 870 1226 237)

6

chapter 6 Traffic Calming for Existing Roads

6.1 Introduction

Definition

Traffic calming can be defined in a variety of ways. To traffic engineers it is seen as a series of physical measures designed to reduce the adverse effects of traffic speed and/or volume in a street. To planners and architects it is seen more as a way of laying out the street and its built environment to reduce the dominance of motor vehicles and promote streets as living areas for people.

Objectives

Traffic calming primarily relates to speed reduction (traffic suppression relates to traffic volume reduction). It is essential that objectives are clarified in advance of designing and implementing any traffic calming scheme. Traffic engineers have employed traffic calming techniques primarily to tackle speeding and speed related road accident problems on existing roads. These have proved necessary because the design of many roads has done little to restrict vehicle speed and does not provide more vulnerable road users such as pedestrians and cyclists with adequate facilities for their needs. Residents have become concerned about their own safety and that of their families. Traffic calming measures have generally been very successful at tackling these problems and have saved many people from death and injury. However, some sections of the profession and the public have unrealistically high expectations of what such measures can achieve in practice and insufficient appreciation of their limitations.

Use

At their best, traffic calming measures can be integrated with good street layout and landscaping to change the appearance and feel of a street. This can alter the way drivers perceive the road and achieve a reduction in speed without creating resentment about the traffic calming features themselves. Very often however the measures are simply "retro fitted" to the existing road. Whilst limiting speed they do little to encourage a calm driving culture. Drivers who perceive they are being slowed down unnecessarily can resent traffic calming. Budget limitations, lack of resources, time constraints or lack of effort or imagination on the behalf of designers are common reasons for the latter effect.

Traffic calmed street

At their best, traffic calming measures can be integrated with good street layout and landscaping to change the appearance and feel of a street.

European experience

The concept of traffic calming originated in mainland Europe. The Dutch were the first to use physical measures to reduce the dominance of motor vehicles in their "Woonerfs" (living areas). In the Woonerfs, drivers had to travel at low speeds and share road space with pedestrians and cyclists. Residential areas were split into zones linked only by pedestrian and cycle routes, which removed through traffic. The streets were redesigned and parking arrangements reorganised to create lateral deflections. A lot of money was spent on environmental enhancement such as block paving and landscaping to create an area that had a pedestrian priority feel. The traditional provision of separate footways was abandoned in favour of a shared surface. Vertical deflections were not widely used in these schemes.

With the success of these measures their use spread throughout much of Europe in the 1970s and early 1980s. Countries such as Germany and Denmark, where concern about environmental and road safety issues were well advanced, developed further traffic calming techniques. In Holland, Germany and Denmark, environmental issues have had a significant role in the justification for providing traffic calming. Budget allocations for schemes have been higher and emphasis has been placed on using high quality materials together with hard and soft landscaping. Vertical deflections have not been so heavily relied upon.

'Woonerf' layout

Bends in the road reduce excessive forward visability and control speed on new roads

UK experience

Traffic calming started in the UK in the late 1970s. Schemes consisted primarily of road humps (ramps). A succession of revisions to regulations between 1983 and 1999 have allowed much greater flexibility in the type and dimensions of traffic calming features that can be used in the UK.

In the UK, vertical features such as ramps have been relied on heavily in many areas (often as accident reduction schemes). There has been a backlash against their use in some areas mainly as a result of unwelcome (and largely unanticipated) side effects such as noise and problems for bus and emergency services. However, many traffic calming schemes have been successfully implemented and have resulted in impressive savings in accidents (up to 70%) and reductions in speeds (up to 10mph).

Irish experience

Irish urban traffic calming schemes were first implemented in the 1970s in Shannon and Dublin. Most roads authorities have found them to be an effective tool for reducing vehicle speeds and road accidents on residential roads. Traffic calming on approaches to towns and villages on national routes was undertaken throughout the 1990s. Although there is little published information as yet on the effectiveness of traffic calming measures in Ireland, two studies are currently underway. The first of these is a report from University College Cork,[93] evaluating traffic calming on inter-urban roads in Ireland. The second is a report from the National Roads Authority,94 evaluating traffic calming on national routes. Traffic calming measures for smaller towns (Fermoy and Mitchellstown)95,96 were discussed in some accident studies in the mid-1980s.

Ramps have become commonplace in urban residential streets and have often been applied to single roads. These seem to have been fairly well accepted but care needs to be taken that "traffic calming" does not become synonymous with "ramps" and that a variety of appropriate features are used. Horizontal deflections and closures are rarely used and more consideration should be given to them when designing schemes. High quality finishes and landscaping should be incorporated into schemes wherever possible.

New roads

Ramps and chicanes are generally remedial treatments for problems on existing roads. They should not be used on new residential streets. For new roads the opportunity exists to limit speeds using a variety of mainly horizontal alignment constraints that are designed to complement the new road's environment. The careful positioning of buildings, landscaping and the materials used can help to reinforce the need to reduce speed and reduce the dominance of motor vehicles (Section C, Chapter 7).

The way forward

It is important to ensure that the side effects of traffic calming schemes as well as the benefits are recognised and considered by professionals and the community at large. Public consultation and participation in the development of schemes is essential to ensure that the measures are well accepted by the majority of people (Section B, Chapter 3). Traffic calming should not be seen and used as a panacea for traffic problems that it cannot realistically solve. This is crucial if traffic calming is to remain an appropriate and acceptable traffic management tool.

6.2 Legislation and procedures

Legislation and regulation

In 1988, the Road Traffic (Bollards and Ramps) Regulations (S.I. No. 32 of 1988) were introduced. This allowed road authorities to construct ramps, subject to quite stringent restrictions. These restrictions were relaxed in the Road Traffic Act, 1994, which now allows considerable flexibility in the types, dimensions and spacing of traffic calming features.

Design advice

Design advice is contained in the following NRA documents

- RS.387A – Speed control devices for residential roads, 1993 (now superseded by this publication)
- RS.387B – Speed control devices for roads other than residential, 1993
- Guidelines on Traffic Calming for Towns and Villages on National Routes, 1999

The design advice for residential roads has been superseded as a result of the relaxations allowed in the Road Traffic Act 1994 and by developing practice from Ireland and the rest of Europe. This chapter will provide advice and references on good practice in the design and implementation of traffic calming schemes on existing roads in urban areas.

Procedures for implementing traffic calming schemes

Under Section 38 of the Road Traffic Act 1994, a road authority may, in the interest of the safety and convenience of road users, provide such traffic calming measures as they consider desirable in respect of public roads in their charge.

It should be noted that additional procedures must be followed for traffic calming measures which are prescribed by the Minister (see sub-section 3 of Section 38). To date, no traffic calming measures have been prescribed by the Minister so these specific procedures are not required.
If traffic calming measures include the provision of regulatory signs, then the normal requirement of consulting with the Garda Commissioner in respect of such signs, must be followed.

Traffic calming measures on a national road shall not be provided or removed without the prior consent of the National Roads Authority.

Tables 6.1 (a) and (b) provide a checklist of relevant legislation pertaining to various construction works and traffic measures (including traffic calming & traffic management).

TABLE 6.1a Legislation pertaining to Road Works & other works

Construction Works	Relevant Legislation
Construct a new road or widen/realign an existing road where it is a: – Motorway – Busway – new or widened road of 4 or more lanes which would be 8km or more in a rural area or 0.5km or more in an urban area – new bridge or tunnel which would be 100 metres or more in length – Proposed road development which would be likely to have significant effects on the environment	**Environmental Impact Statement (EIS) must be prepared:** Section 50 of Roads Act, 1993 Part 5 of Roads Regulations, 1994 (S.I. No. 119 of 1994) Article 14(a) of the European Communities (EIA) (Amendment) Regulations, 1999 (S.I. No. 93 of 1999)
Construct a new road or widen/realign an existing road **where a scheme does not require an EIS** but where it is: – 100 metres or more in an urban area – 1km or more in a rural area – a new bridge or tunnel	Section 179 of the Planning and Development Act, 2000 refers; Requirements set out in **Part 8 of the Planning and Development Regulations, 2001**
Abandonment of a public road	Section 12 of the Roads Act, 1993
Extinguishment of a public right of way	Section 73 of the Roads Act, 1993 And also Section 222 of the Planning and Development Act, 2000

TABLE 6.1b Legislation pertaining to Traffic Calming/Management

Traffic Calming / Management Measures	**Road Traffic Acts 1961, 1968, 1994 & 2002** **Road Traffic (Traffic and Parking) Regulations, 1997 (S.I. No. 182 of 1997) & Amendment Regulations, 1998 (SI 274 of 1998)** **Road Traffic (Signs) Regulations, 1997 (S.I. No. 181 of 1997) & Amendment Regulations, 1998 (SI 273 of 1998)**
Apply a Weight Restriction	Article 17 of S.I. No. 182 of 1997 makes provision for prohibiting vehicles above a specified weight from entering a road. Sign Number RUS 015 from S.I. No. 181 of 1997 is an example of the type of sign which must be used.
Apply a Height Restriction	Article 34 of S.I. No. 182 of 1997 makes provision for prohibiting vehicles above a specified height from proceeding past traffic sign number RUS 016. The Second Schedule of S.I. No. 181 of 1997 gives details of RUS 016.
Direction to Proceed along a Particular Route	Article 22 of S.I. No. 182 of 1997; Article 5 of S.I. No. 181 of 1997
Prohibit straight ahead or right or left turn movements	Article 23 of S.I. No. 182 of 1997; Article 6 of S.I. No. 181 of 1997
Apply Parking Restrictions	**Articles 36 to 45 of S.I. No. 182 of 1997** Article 36 - Prohibitions on Parking; Article 37 - Restrictions on Parking; Article 38 - Restrictions on Parking Heavy Goods Vehicles; Article 39 – Parking in Bus Lanes; Article 40 – Clearways; Article 41 - Prohibitions on Parking at School Entrances; Article 42 – Parking in Loading Bays; Article 43 – Disabled Persons' Permits; Article 44 – Disabled Persons' Parking Bays; Article 45 – Pedestrianised Streets **Articles 14 to 20 of S.I. No. 181 of 1997** Article 14 – Single Yellow Lines; Article 15 – Double Yellow Lines; Article 16 – Loading Bay; Article 17 – School Entrance; Article 18 – Parking Bays; Article 19 – Disabled Persons Parking Bay; Article 20 – Disc Parking Area
Apply Parking Charges	Sections 36 of the Road Traffic Act, 1994
Bus Lanes & Bus only street	Article 32 of S.I. 182 of 1997; Article 27 of S.I. 181 of 1997 Sign RUS 021 (Pedestrian only street) is used in association with an information plate to indicate a bus only street
Bus Stop	Under Sections 85 & 86 of the Road Traffic Act, 1961 the Garda Commissioner may specify stopping places and stands for buses and may make bye-laws in respect of same. When commenced, Section 16 of the Road Traffic Act, 2002 will devolve this function to Road Authorities. No date has yet been fixed for devolving this function. Articles 41 & 42 of S.I. 181 of 1997
Taxi Stand	From 1st February 2003, Road Authorities may make bye-laws for Taxi Stands under Section 15 of the Road Traffic Act, 2002 Article 32 of S.I. 181 of 1997
Cycle Tracks	S.I. 273 of 1998; S.I. 274 of 1998
Cycleway	Section 68 of Roads Act, 1993
Traffic Lights	Article 30 of S.I. 182 of 1997; Articles 33, 34, 35, 36 of S.I. 181 of 1997
Pedestrian Crossing (Zebra) & Crossing Complex	Article 46 of S.I. 182 of 1997; Articles 38 & 39 of S.I. 181 of 1997
Pedestrian Crossing Signals	Article 30 of S.I. 182 of 1997; Article 40 of S.I. 181 of 1997
Cycle Crossing Signals	Article 10 of S.I. 273 of 1998; Article 9 of S.I. 274 of 1998
No Entry	Article 28 of S.I. 182 of 1997; Article 23 of S.I. 181 of 1997
Speed Limits	Road Traffic Act, 1961, Road Traffic Act, 1968 & Sections 30 to 34 of the Road Traffic Act, 1994
Traffic Calming Measures	Section 38 of the Road Traffic Act, 1994

Public consultation

Although not specifically required, public consultation is an important part of the process for the design and implementation of traffic calming schemes. This is dealt with in detail in Section B, Chapter 3.

Consultation with emergency services organisations and bus operators

Whilst traffic calming measures offer general benefits to society as a whole, their provision could affect the operations of An Garda Siochana, fire, ambulance and bus services. It is important that these organisations be consulted. This is dealt with in Chapter 6.3 and Section B, Chapter 3.

Whilst traffic calming measures offer general benefits to society as a whole, their provision could affect the operations of An Garda Siochana, fire, ambulance and bus services. It is important that these organisations be consulted.

6.3 Emergency Service access requirements[16]

There is now a substantial body of evidence that well-designed and delivered traffic calming schemes are very effective at reducing road accidents and reducing excessive and inappropriate motor vehicle speeds. This success in turn reduces the drain on national resources for health care and emergency services costs. However, fire and ambulance services may have particular concerns about response times to emergency calls in general or in certain areas. This is especially true in access controlled areas (eg residential development with electronic gates).The cumulative effect of the growing number of traffic calming schemes may increase concern about response times.

There are also concerns about damage to specialist equipment carried by these services. Traffic calming schemes may lead to increased discomfort for drivers, passengers and patients in ambulances. Some fire services regularly use particular routes to respond to emergency calls.

Road authorities should consult with fire and ambulance services when designing their schemes, in the interests of maintaining effective emergency services. Road authorities should establish a constructive working relationship with these services and discuss traffic calming proposals at an early stage of the design process. It may be possible to agree that certain types of measures (such as speed cushions) that are more acceptable are used on sensitive routes. If the emergency services are unsure about new types of measures then undertaking trials to assess their suitability would be a positive step.

The emergency services should monitor response and journey times before and after the installation of traffic calming and discuss the results with the road authority. It should be noted that bus lanes are a vital part of the emergency service network.

6.4 Strategies for the use of traffic calming

Urban areas

Many traffic calming schemes are introduced as isolated treatments or along a route to solve a particular problem. While solving problems locally this can affect the traffic flow on the rest of the road network. It is important to ensure that if traffic is diverted it is not merely being diverted into adjacent residential streets, exacerbating problems there. Ensuring that traffic is managed onto more appropriate roads is a fundamental feature of an Urban Safety Management strategy.[8] Such a strategy looks at the problems of an urban area as a whole and requires a structured systematic approach to managing traffic onto the most appropriate roads and treating traffic safety problems.

As part of a strategy to treat whole urban areas, a series of localised area wide approaches to managing traffic can be appropriate. Often these are linked to the introduction of a 20mph speed limit. This helps to minimise the risk of diverting traffic onto roads that are not suitable for dealing with increased levels of traffic.

A typical area-wide strategy would define a problem area using main roads (that can carry any diverted traffic) to define the boundaries (see Diagram 6.2). The area would be split up into smaller zones where traffic calming measures (on their own or in conjunction with other traffic management measures) would be introduced in stages over a period of time. The sequence of staging could then address the issue of diverting traffic to minimise the potential adverse impact.

Rural areas

Detailed consideration of traffic calming for rural roads is beyond the scope of this manual. The NRA has published "Guidelines on Traffic Calming for Towns and Villages on National Routes, 1999" and this contains useful advice on such measures. A number of other reference documents concerning these measures are listed in 6.15 at the end of this chapter.

6.5 Selection of appropriate measures

General

Traffic calming measures can be very beneficial to the local environment if used wisely. However they can also bring unwanted side effects such as noise and discomfort. In considering the most appropriate solution to a problem, alternatives such as road closures (partial, part-time, permanent etc.) should be considered first. If these are not feasible and a traffic calming scheme is required to mitigate the problems,

Diagram 6.1 Fire service vehicle trialling different traffic calming measures

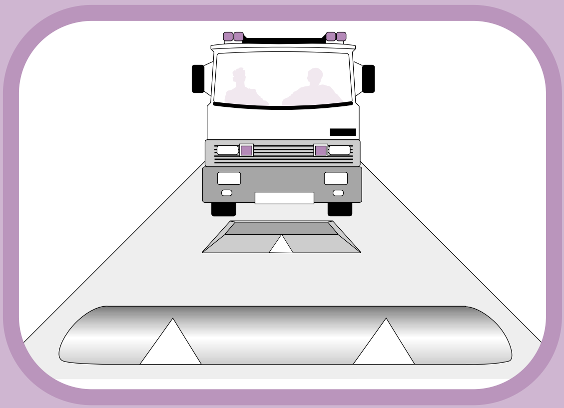
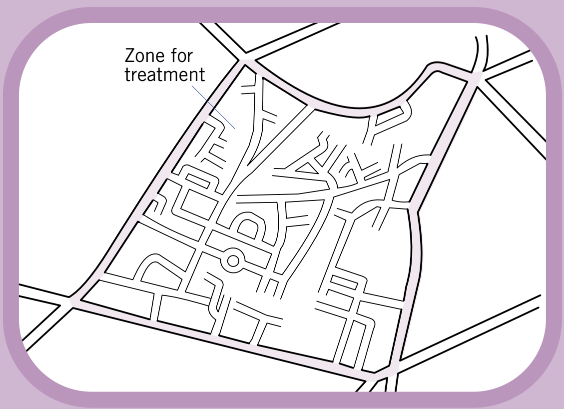


Diagram 6.2 Area wide treatment



careful consideration should be given to the type of measures that are most appropriate. While ramps are relatively cheap to install and maintain they do little to enhance the local environment and can easily be overused. The cumulative effect of successive ramp schemes could lead to unpopularity with drivers and residents.

Schemes should seek to include elements of enhancement in terms of both soft and hard landscaping. The inclusion of planting and the reduction of excessive forward visibility can help to reinforce the impression that drivers should be driving slowly. Schemes that incorporate appropriate enhancement measures are likely to be better accepted by residents and drivers.

Schemes using horizontal measures should be promoted more where appropriate. Ramps should only be chosen if no other suitable measures can be used.

On-street parking can be accommodated within traffic calming schemes where there are insufficient off-road spaces. This should be possible on most roads with flows up to 7,000 vehicles per day and on wider roads (10m or more with higher traffic flows. Build-outs and other horizontal measures can be used to shelter parking spaces and reduce speed.

Table 6.2 gives guidance on the type of traffic calming measures which can be used on various road categories.

Ramps should only be chosen if no other suitable measures can be used.

TABLE 6.2 SELECTION OF APPROPRIATE TRAFFIC CALMING MEASURES

MEASURE	TYPE OF ROAD		
	District Distributor	Local Collector	Access Road
Road closure	✗	✗	✓
Traffic island	✓	✓	✗
Gateway	✓	✓	✗
Entry treatment	✗	✓	✓
Overrun area	✓	✓	✓
Rumble device	✓	✗	✗
Mini-roundabout	✓	✓	✗
Build-out/Parking	✓	✓	✓
Pinch point	✗	✓	✓
Chicane	✗	✓	✓
Ramp	✗	✗	✓
Speed table	✗	✓	✓
Speed cushion	✗	✓	✓

6.6 Benefits and potential drawbacks

Traffic calming schemes are generally provided to tackle problems with speeding vehicles and accident problems and help to improve safety for pedestrians and cyclists. They can, however, have potential drawbacks.

The main benefits and potential drawbacks associated with traffic calming schemes are summarised in Table 6.3.

Producing a balanced scheme

When considering a traffic calming scheme as a solution to a traffic management problem, it is important to seek to minimise the potential drawbacks of the scheme. An acceptable balance has to be struck. The potential drawbacks as well as the benefits must be explained to interested parties. Effective local public consultation and participation can help to give people the scheme that matches most closely their needs. Advice is given here and in following sections on the main issues likely to arise and how these can be taken into account and how potential drawbacks can be mitigated.

It should be emphasised that with traffic calming, as with many other traffic management issues, it is difficult (if not impossible) to produce a scheme that pleases everybody. However every effort should be made to produce a scheme that has the support of a majority of people, whilst fulfilling the basic objective of the scheme. It would be inadvisable to proceed with a scheme that does not have support without having given serious consideration to alternative solutions.

6.7 Road closures

General

Road closures should always be considered as an alternative to traffic calming if the main problems are caused by through traffic that does not need to be on the road being considered for treatment. The form of road closure is usually a prohibition of driving over a short length of road, which is enforced by physical measures such as kerbs and bollards. The position of the length

Table 6.3 Main benefits and potential drawbacks of traffic calming schemes

Benefits

– Reduces vehicle speeds
– Reduces the number and severity of accidents
– Lessens concern over road safety
– Reduces the dominance of motor vehicles
– Encourages walking and cycling
– Reduces the feeling of community severance
– Can be integrated into enhancement and regeneration schemes

Drawbacks

– Can cause discomfort for drivers and passengers particularly those with back or neck problems
– Can damage vehicles if driven over too quickly and result in increased maintenance costs
– Can delay emergency service vehicle response times and result in damage to their equipment and vehicles
– Can increase bus journey times
– Can increase noise and vehicle emissions: – usually associated with braking or acceleration of vehicles and body/load noise for lorries.

Diagram 6.3 Possible road closure locations

of road over which the closure is applied needs to be chosen carefully so that through traffic is diverted onto suitable alternative routes and the problem is not merely transferred onto adjacent residential roads.

It is possible to exempt certain classes of vehicle (generally cycles, emergency service vehicles and bus services) from the prohibition. This can help to remove some of the objections to closure but needs careful thought about how it will be enforced. It is unrealistic to expect Gardai to actively enforce closure because of resource constraints and priorities. A scheme should therefore contain self-enforcing engineering measures. Cyclists can be provided with gaps or bypasses. Demountable bollards can give access to emergency service vehicles. Bus entries (Section F, Chapter 15) can be provided to give access to buses, and can be lowered during off peak periods, if desired.

Road closures are generally cheaper than traffic calming schemes to construct but can take up a lot of staff time in dealing with consultations and objections. This however can be offset against savings in design time for alternative traffic calming measures. Road closures need careful consultation with local residents who may have to make longer journeys.

One of the main problems with the implementation of road closures is gaining a majority of local public support. The effects of the closure on the rest of the road network will also need to be considered. Alternative routes will need to be able to cope with the additional volumes of traffic, particularly in the peak hours.

If it is not possible to proceed with a closure then a traffic calming scheme may help to mitigate some of the problems and result in a proportion of drivers seeking alternative routes (see Chapter 6.14).

6.8 Traffic Islands[22] (Refuges)

General

Traffic islands or refuges can be used for a variety of purposes including:

- providing a facility for pedestrians and cyclists to cross a road
- providing a location for street furniture such as signs and signal poles (including gateways)
- segregating different streams of traffic (including cycle bypasses at traffic calming measures)
- as part of traffic calming schemes to narrow the road or provide deflection of vehicle paths in order to reduce speeds
- preventing overtaking and reducing speed by channellising traffic

Islands should be carefully situated so as to avoid obstructing access to properties and thought should be given to the consequences for future maintenance of the road on which they are placed. Adequate street lighting should be provided where islands are to be installed.

Pedestrians

Traffic islands can provide significant benefits for pedestrians wishing to cross a road without affecting traffic capacity. A ‘string’ of refuges (see Diagram 6.4) can be provided along a length of road where pedestrian crossing demand is not concentrated at a single point and where a controlled crossing such as a pelican crossing could not be justified. Refuges can also be incorporated into the hatched areas of turning lanes. Where pedestrians are likely to use an island, dished crossing points (flush with road surface or with a maximum upstand of 6mm) should be provided at both sides of the road. The minimum width of the island should be 2m (see Diagrams 6.5 and 6.6) but 1.5m will suffice if road space is tight. If it is not possible to fit in a 1.5m wide island then

a substandard one of 1.2m width could be considered. This may be better than no island at all. Pedestrians must have adequate visibility of approaching vehicles and vice versa.
Islands which are not located at junctions can cause a driving hazard if installed in isolation.

Cyclists

Cyclists can feel "squeezed" at islands where the road is narrowed. For widths between 3m and 4m a cycle bypass should be provided where appropriate (see also Chapter 6.12.1).

Signing

Refuges should incorporate signing to indicate which side of the island drivers and riders should pass. The signs are commonly in the form of internally illuminated "keep left" or "plain faced" bollards. When used on higher speed roads (85% speeds of 35mph and above) supplementary high mounted reflective "keep left" signs can be used to improve conspicuity of the islands. These signs give drivers better advance warning of the islands and reduce the likelihood of drivers running into the islands (and the consequent cost of maintaining the bollards). Any signs placed on the islands should have a clearance of 0.45m from the kerb edge.

Longer Vehicles

Traffic islands can present problems for longer vehicles, which may have difficulty in negotiating the island. This can be a problem when long vehicles are turning at a junction or access point and the islands are too close. Similarly if vehicles park close to the island then this can obstruct the passage of long vehicles. In such situations drivers of longer vehicles may have to (illegally) pass the island on the wrong side in contravention of the "keep left" sign. Where traffic islands are provided adequate clearance for vehicles likely to use the road should be provided.

It may be necessary to check use by abnormal loads and in rural areas particular attention will need to be given to the access requirements of tractors and other agricultural vehicles.

Diagram 6.4 Traffic islands for pedestrians

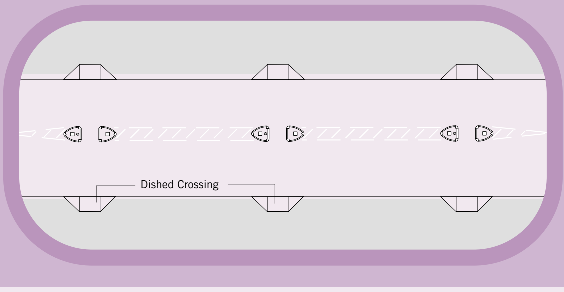
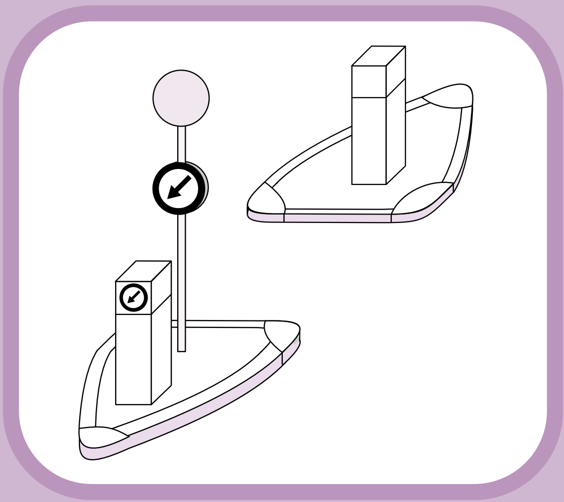


Diagram 6.5 Traffic island



Series of Traffic Islands

Lighting

Traffic islands should be illuminated so that road users can see them in the hours of darkness. Where islands have been provided without adequate illumination the risk of vehicles colliding with them is significantly increased. Lighting can be incorporated into the design of the island to improve its conspicuity. The provision of internally illuminated bollards is also desirable in this regard.

6.9 Gateways and Entry Treatments

General

Gateways and entry treatments are features which are intended to alert drivers to the fact that they are entering an area or length of road that has a different driving environment. They may have only a small effect on traffic speeds if used on their own and vehicles will speed up again after passing the feature.

Gateways commonly consist of one or more of the following:

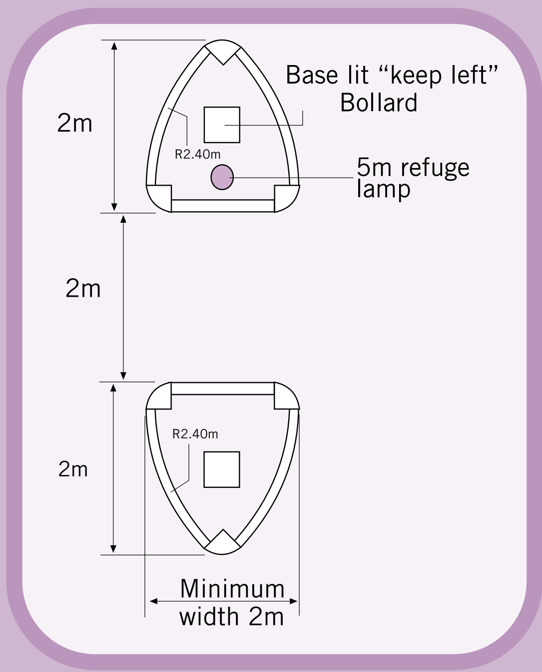
- a higher level of signing and road markings
- the use of contrasting surface colour or textures
- street furniture such as bollards and timber posts
- vertical or horizontal deflections such as ramps or build-outs
- hard and soft landscaping

Gateways[13,50,51,88]

Gateways are commonly used on approaches to urban areas or villages, often in conjunction with a speed limit, or at the start of a traffic calming scheme. Their purpose is to slow down speeding drivers and make them more aware that the road they are entering is one where people live. Gateways should be sited so that they are clearly visible to drivers approaching them for at least the safe stopping distance appropriate for the 85%ile speed of traffic.

Gateways are more effective if the signing and road markings are highly conspicuous and incorporate other forms of physical traffic calming such as road narrowings, islands or chicanes. Gateways offer good opportunities for landscaping but this should be carried out in a way that is sympathetic to the local

Diagram 6.6 Traffic island incorporating street furniture, signing and lighting plan view



Traffic island with ramp

Gateway entering a town

environment. The advice of a landscape architect or conservation officer should be sought. The NRA "Guideline on traffic calming for towns and villages on national routes, 1999[88]" gives useful guidance on landscaping.

Experience in the UK[17] suggests that more severe gateways incorporating physical measures can attain speed reductions of between 5mph and 10mph, but that drivers will speed up again after passing them unless further measures to reduce speed along the length of a road are taken.

Entry treatments[15]

Entry treatments are normally used in urban areas to indicate the start of a traffic calming scheme often where drivers turn off a major road into a minor side road (AADT of 5000 or less). They commonly incorporate:

- raised areas of a high quality material, which contrasts with both the road surface and the footway surface. These are often raised to the footway level or dropped kerbs used to provide convenient crossing points for wheelchair and pushchair users. Appropriate tactile paving should be provided (see Chapter 13).
- high quality street furniture such as cast iron or timber bollards, which are used to enhance the feature and prevent vehicles overrunning the footway. Bollards and other street furniture should contrast in colour with the road surface and be located a minimum of 0.5m back from the kerb face. Bollards should incorporate reflective strips where appropriate. Bollards should not obstruct pedestrian movement across the entry treatment.
- landscaping to heighten the visual impact. This should not obscure drivers' and pedestrians' visibility of each other.
- reduced corner radii and build-outs on the side road. The corner radii can be reduced to 6m where large vehicles only require occasional access. The build-outs on the side road can help to shelter parking and reduce the width of the mouth of the junction for pedestrians to cross. A road width of 6m at the build-outs will cope with most traffic flows on the side road. This can be reduced to 5m if the side road is lightly trafficked.
- speed limit signs if appropriate.

Entry treatments are most effective if located prominently at the mouth of the junction. They will be more obvious to drivers on the major road and will provide an improved crossing opportunity for pedestrians. However, two-wheeled vehicles turning left into

Entry treatment incorporating raised area of contrasting surfacing the side road will have to negotiate any raised feature at an angle and it is important that the materials chosen are not slippery when wet.

Pedestrians will find the raised area of an entry treatment an attractive and convenient location to cross the mouth of the junction. The use of contrasting materials will alert pedestrians to potential conflicts with cars. Dished crossing points (flush with road surface or a maximum of 6mm upstand) should be provided where pedestrians cross the road and elsewhere a minimum kerb upstand of 25mm should be maintained (Section E, Chapter 12 and 13).

6.10 Overrun areas and Rumble Devices

6.10.1 Overrun areas[12]

General

Overrun areas are areas of material that contrast visually and texturally from the normal road surface. Their purpose is to create the appearance that the carriageway is narrower than it actually is, and to help reduce vehicle speeds particularly those of cars. Car drivers are discouraged from encroaching into the overrun areas but long vehicles can mount these if necessary.

Overrun areas are commonly used at the following locations:

- bends and junction radii – to reduce the effective corner radii for smaller vehicles where longer vehicles must still be catered for
- roundabouts – to increase the effective deflection for smaller vehicles by deploying the overrun area around the central island
- road narrowings and islands (refuges) – to increase the effective deflection for smaller vehicles at the edge of the carriageway or alongside the narrowings

Diagram 6.7 Overrun area at corner of junction

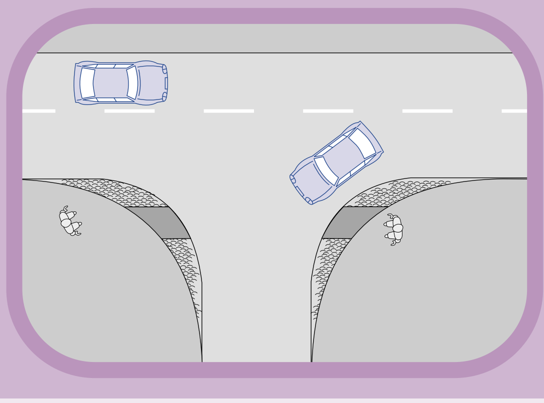
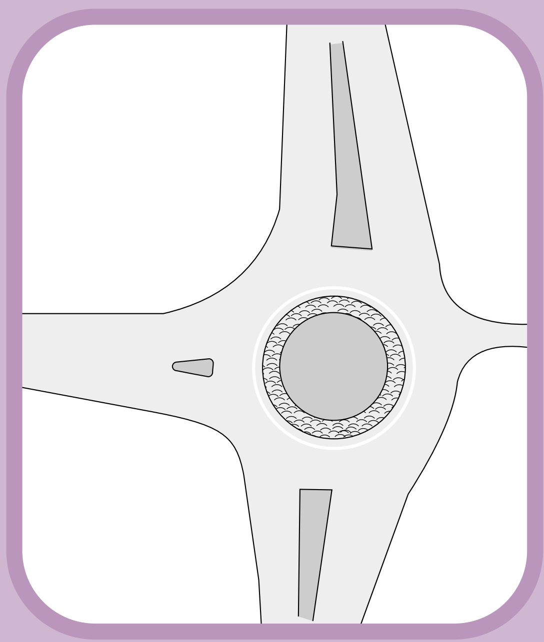


Diagram 6.8 Overrun area at roundabout



Height and materials

Raising the overrun areas and using rough textured material can enhance their effectiveness as this further discourages cars from encroaching onto the areas. Care does need to be taken that the raised areas do not de-stabilise two-wheeled vehicles or form trip hazards in areas where pedestrians may seek to cross a road.

If pedestrians are likely to cross at an overrun area then a path should be left clear of rough textured material and kerb upstands, so that pedestrians are less likely to trip.

The overrun areas can be raised from the existing carriageway and sloped. There are no prescribed dimensions for overrun areas but guidance on dimensions is given in a UK advice leaflet.[15] A maximum edge upstand of 15mm, with a vertical face not exceeding 6mm, together with a slope angle of 15° is recommended. The edge upstand can be achieved by using a 16–19mm radius bull-nose kerb.

Signing and lighting

Road users (particularly cyclists and motorcyclists) need to be able to see overrun areas clearly in both day and night light conditions. Street lighting should allow all road users to see the contrasting colours and textures thereby allowing them to choose the correct path. In unlit areas they may be difficult to see in darkness and therefore they may need to be specifically illuminated.

6.10.2 Rumble Devices[11]

General

Rumble devices are features that create a vibratory or audible effect at a location where drivers should slow down or take greater care. They are only used at rural locations, on the approach to a bend or junction, at the entry to a built-up area such as a village or incorporated into gateways. Rumble devices consist of a series of raised strips often in a colour that contrasts with the existing road surface.

Diagram 6.9 Overrun area at island

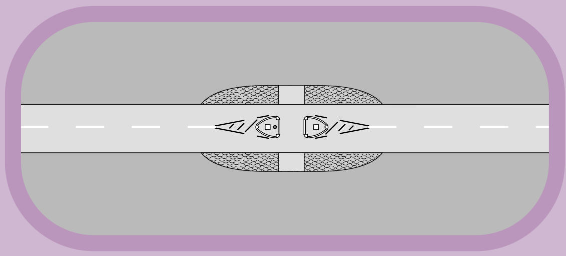
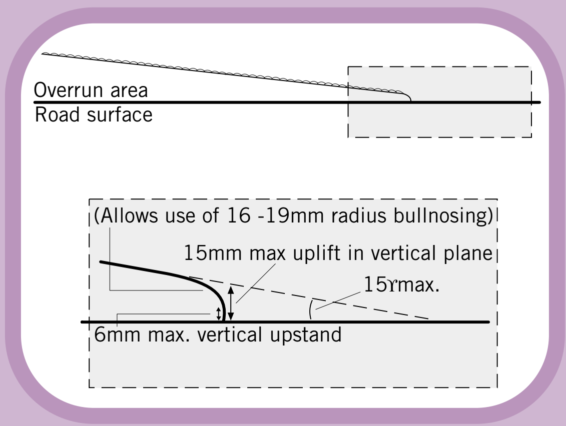


Diagram 6.10 Use of inclined overrun areas



Rumble strips on approach to a junction

Dimensions and layout

There are no prescribed dimensions for rumble devices in Ireland. UK regulations allow a height of up to 15mm providing there is no vertical face greater than 6mm, as with overrun areas.

The spacing between features can be varied. They can be laid in groups or in a single sequence. Guidance on the use of rumble devices is given in a variety of reference documents listed at the end of this chapter. Particular attention is drawn to RS.387B "Speed control devices for roads other than residential."[87] The strips are generally terminated before the edges of the road to allow them to drain adequately and allow cyclists a judder free route.

Noise

If rumble devices are located in the vicinity of residential properties then the noise that they generate can be a cause for concern. If they are to be located within 200m of a residential property then residents should be consulted over their use. There are examples where these measures have been installed close to isolated properties and the residents have campaigned for them to be removed. Similarly there are cases where residents have been consulted prior to installation and have accepted them (despite the nuisance) because of their concerns about speed or safety.

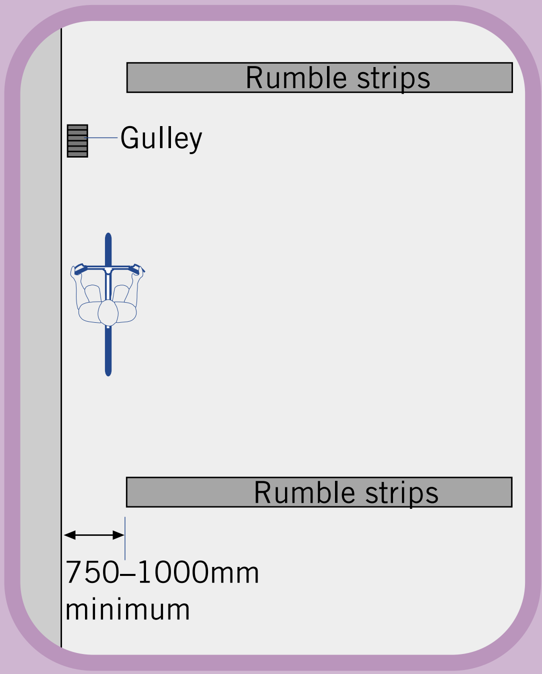
Use in urban areas

In urban areas, rumble devices have been used in new residential roads (in culs de sac, to signify the start of a shared use area) and in car parks where speeds are very low. They have been tried on busier urban roads, but generally with little success. On some roads the devices have had to be removed because of complaints about the additional noise that they generated.

Effectiveness

Evidence on the speed reducing effect of rumble devices is not robust. They are likely to have only a small impact on speeds if used on their own. However they do increase drivers' awareness and can reduce accidents significantly because of this.

Diagram 6.11 Termination of rumble devices at edge of carriageway



6.11 Mini-roundabouts[81]

Introduction

Mini-roundabouts consist of small painted central islands (between 1m and 4m in diameter) with arrows indicating the direction in which vehicles are required to proceed around them (Diagram 6.12).

The islands may be flush or slightly "domed" (a maximum of 75mm high is recommended) and can be overrun by longer vehicles. Doming should be a maximum of 25mm high if buses turn right at the mini-roundabout. Mini-roundabouts are generally installed at existing 3 or 4-arm priority junctions in order to reduce accidents, vehicle speeds or to relieve queuing on the minor road. They can often be introduced with a minimum of alteration to the existing kerb lines in order to keep costs down.

It is more difficult to physically constrain speeds with mini-roundabouts because of their comparatively small size. Because of this, mini-roundabouts should not therefore generally be used on roads with 85% speeds greater than 30mph unless measures to reduce approach speeds are incorporated into the design. Mini-roundabouts should not be used on roads with 85%ile speeds greater than 40mph.

Applications

Mini-roundabouts can be used to reduce queues on side roads at locations where this is desirable. Care is needed that they are not used to exacerbate problems with rat-running traffic by allowing better access from the rat-run route onto the main road network. Mini-roundabouts should be regarded as a remedial measure to treat specific problems on existing roads rather than as a general traffic management solution. Where possible, the use of mini-roundabouts should be exceptional and limited to roads with low speeds. Their use has increased in recent years, often as part of traffic calming schemes where approach speeds are likely to be lower than on other roads. In such situations it may be that they have a lower accident rate.

Diagram 6.12 Mini-roundabout

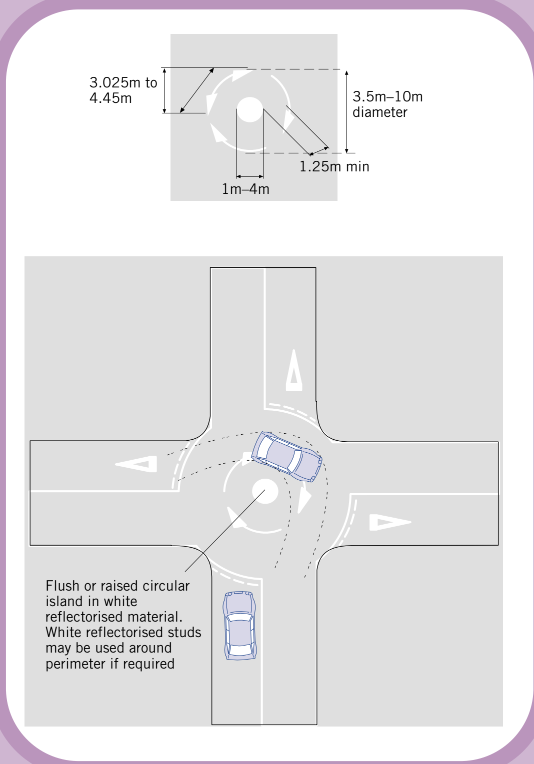
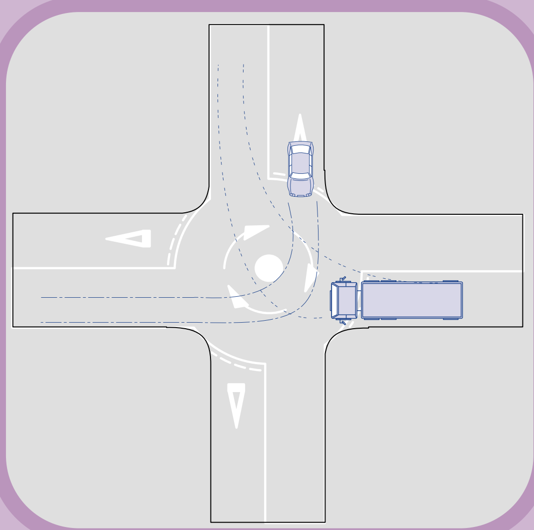


Diagram 6.13 Turning circles around mini-roundabout



On roads where 85% speeds are between 30mph and 40mph the following features should be incorporated into the design to reduce approach speeds and alert drivers to their presence (see Diagram 6.15):

- the introduction of some vehicle entry path deflection by "doming" the central island, building out kerb lines or hatching out with white lines on the approaches
- the introduction of splitter islands at the approaches to constrain racing lines and to house signs
- the introduction of improved signing (e.g. advanced warning signs, the doubling up of signs on the nearside and offside at the approach to create a gateway effect)
- the provision of high-friction surfacing
- the provision of a traffic islands or road narrowing in advance of the approaches

Care needs to be taken with the positioning of the central island and approach splitter islands to cater for vehicle turning movements. They should be located so that most vehicles can negotiate the central island without having to overrun it where possible.

Accidents

Mini-roundabouts can reduce the number and severity of accidents when introduced at existing problem junctions. However, if used at sites with a good safety record they could worsen it.

The results of a study[65] in the UK are shown in Table 6.4. The mean severity of the accidents was found to be significantly less than for comparable signal and priority junctions, probably because traffic speeds are generally lower at mini-roundabouts than at other forms of junction. A high proportion of accidents involved vulnerable road users (pedestrians and cyclists/motorcyclists).

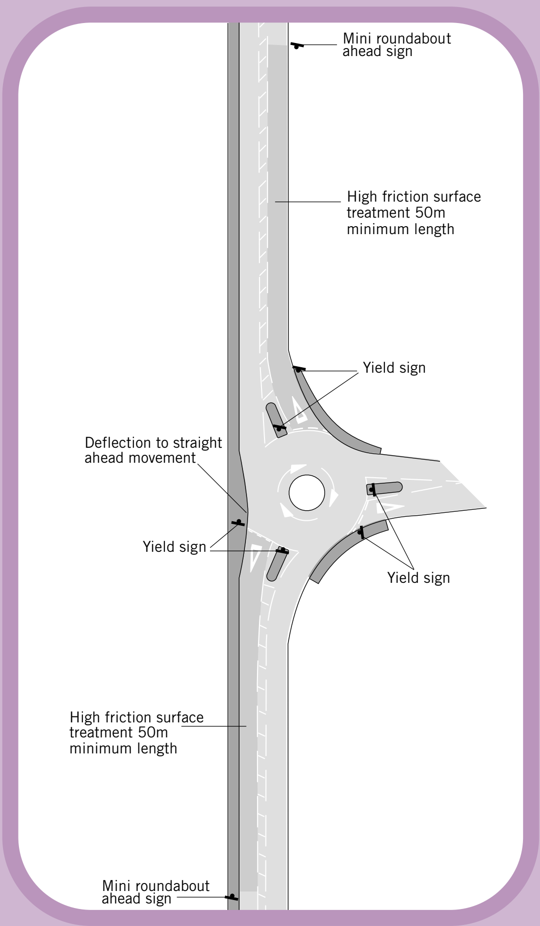
Pedestrians

Consideration should be given to the provision of pedestrian crossing facilities at mini-roundabouts. Where controlled crossings cannot be justified then traffic islands on the approaches should be designed to accommodate pedestrians. The islands should be constructed in accordance with the guidelines in Chapter 6.8. Any signs located on the islands should not obstruct the path or visibility of pedestrians.

Table 6.4 Accidents at mini-roundabouts

Accident factor	3-ARM	4-ARM
Number of injury accidents per year	0.9	1.35
Percentage of fatal and serious accidents	12	14
Percentage of accidents involving –		
Veh. entering hitting veh. circulating	46%	66%
Cyclists	23%	20%
Motorcyclists	17%	17%
Pedestrians	17%	12%

Diagram 6.14 Mini-roundabout with deflection, splitter islands and signing



Cyclists and motorcyclists

It is difficult to accommodate specific facilities for two-wheeled vehicles within mini-roundabouts. If there are significant flows of cyclists along routes where mini-roundabouts are proposed, consideration should be given to alternative forms of junction control. (See Cycle Manual)

Visibility

As with other forms of roundabout it is important that drivers have sufficient advance visibility of the island. This is often an issue when a three-arm mini-roundabout is built offset from the centre line of the main road and a hedge or fence line might obstruct forward visibility. In such cases a forward visibility equivalent to a Stopping Sight Distance (SSD) for the 85% speed of traffic on the road should be attained (see Table 6.5).

Visibility for vehicles at the yield line on this side of the road can be a problem particularly when the yield line is set back from the main road kerb edge. It may be appropriate to apply visibility splay requirements similar to those for priority junctions in this case to ensure that there is adequate visibility to the right for vehicles entering the main road from the minor road.

6.12 Horizontal deflections – Build-outs, Pinch-points and Chicanes

6.12.1 General

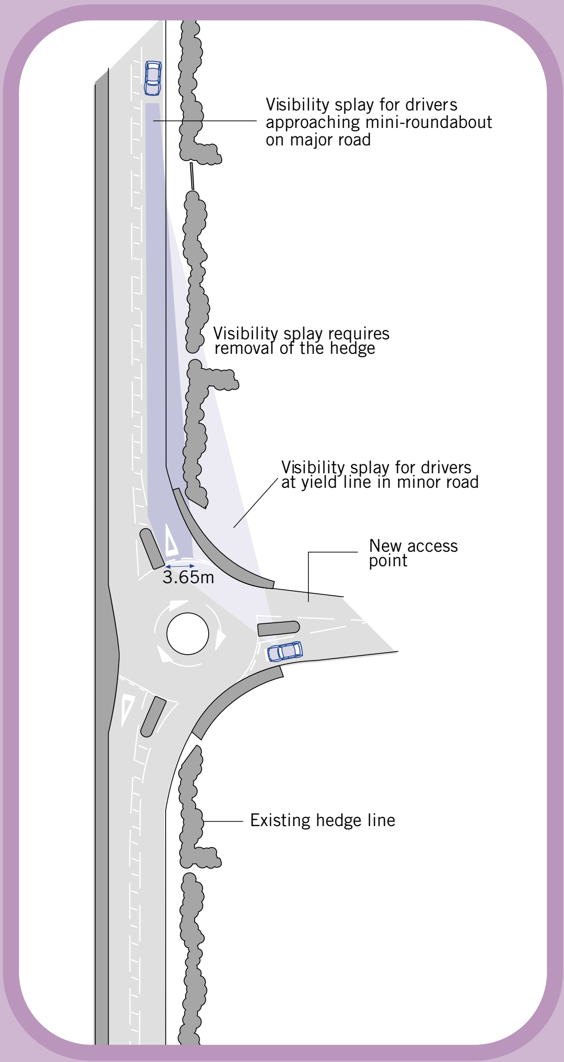
Signing and road markings

Horizontal deflections may need to be signed in advance (for example "Road narrows"). This gives drivers adequate warning so that they can slow down to negotiate the feature. If the road is narrowed to a single lane width then yield markings should be provided to indicate which traffic flow direction has priority. Consideration should also be given to the use of yield signs to indicate priorities in situations where the markings alone would not have sufficient effect. Such situations would include locations where approach speeds may exceed 30mph (e.g. where it is the first in a series of traffic calming measures) or where the markings may be obscured by parked vehicles.

Table 6.5 Stopping sight distance

SSD-30mph	SSD-35mph	SSD-40mph
70m	90m	120m

Diagram 6.15 Visibility required at mini-roundabouts



Narrowings to single lane traffic work best in a series for balanced vehicle flows of between 3,000 and 7,000 vehicles per day. If the traffic flow is below 3,000 vehicles per day, vehicles approaching horizontal deflections rarely have to give way to each other and the measure is ineffective. If the flow is above 7,000 vehicles per day then long queues can form in the peak hours. In off-peak hours vehicles can speed-up to get through the narrowing before an oncoming vehicle

Cyclists

Where the road is narrowed, cyclists can feel threatened by motor vehicles. Drivers may attempt to overtake cyclists where the width is more than 3m and therefore risk hitting them. Where possible, cyclists should be provided with a separate route around the deflection to avoid this conflict (see Diagram 6.17). (See Cycle Manual)

Aesthetics

The use of horizontal deflections often allows scope for enhancement of the road environment. The materials, planting and street furniture (such as bollards) used should be of a high quality. The advice of planners or landscape architects on appropriate materials should be sought. This is likely to enhance both the effectiveness of the scheme and the popularity of the scheme with residents and road users.

Visibility

The features should be located where drivers would have clear visibility of them. Planting and street furniture should not obstruct the visibility of pedestrians who may be crossing nearby. Similarly drivers approaching the feature from opposite directions should be able to see each other and yield (without sudden braking) if necessary (see Diagram 6.18).

Critical widths

If separate cycle facilities are provided the narrowing can be reduced to 3m for residential roads and 3.5m for major roads. If no separate cycle facilities can be provided then a width of 4m is preferable to avoid cyclists being 'squeezed'. Widths of 4.5m or greater may encourage 2 cars to try to get through together.

Diagram 6.16 Signs and markings at one-way road narrowing (centrally located)

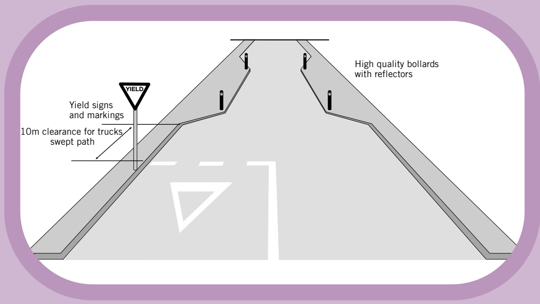


Diagram 6.17 Cycle by-pass at narrowing

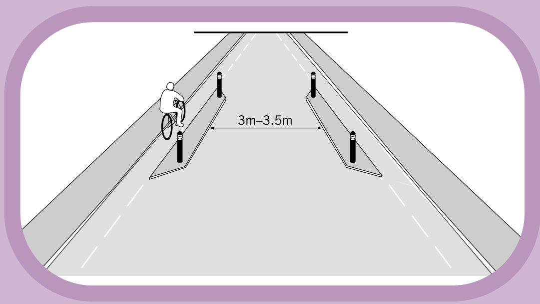
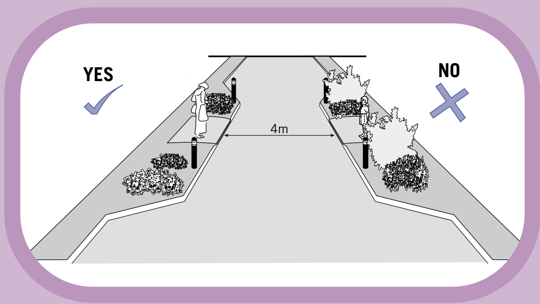


Diagram 6.18 Planting at road narrowing



6.12.2 Build-outs and pinch-point (road narrowings)[19]

Build-outs are an extension of the footway or verge into the road. They can be used for a variety of purposes, including to:

- provide sheltered parking bays
- improve visibility at junctions by allowing the give way markings to be moved forward
- assist in the formation of gateways and entry treatments (Chapter 6.9)
- provide opportunities for scheme enhancement including hard and soft landscaping
- form chicanes and pinch points
- provide bus boarders (Chapter 15.6)

Pinch-points work best when combined with other traffic calming measures such as ramps and speed cushions. When two vehicles are approaching single-way working pinch-points from opposing directions, some drivers approaching the yield sign may speed up to get through the gap before the other vehicle arrives, in order to avoid having to yield. This effect tends to be reduced if there is a ramp or speed cushion within the pinch-point. To be effective on their own, single-way working pinch-points require significant volumes of conflicting traffic. On many residential roads there is insufficient traffic volume for them to work effectively on their own for long periods of the day. Build-outs can also be used to form bus boarders (see Chapter 15.6).

6.12.3 Chicanes[19,29]

Chicanes consist of alternating road narrowings (or footway build-outs) on each side of the road. These induce the horizontal deflection of vehicles, which assists in reducing speed.

There are two main types of chicane:

- single-way working on roads with between 3,000 and 7,000 vehicles per day (controlled by yield markings and priority signs)
- two-way working for flows above 7,000 vehicles per day

Diagram 6.19 Built-out to provide sheltered parking and improve visability at junction

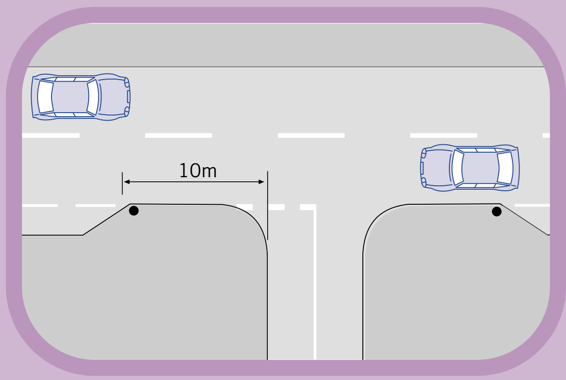
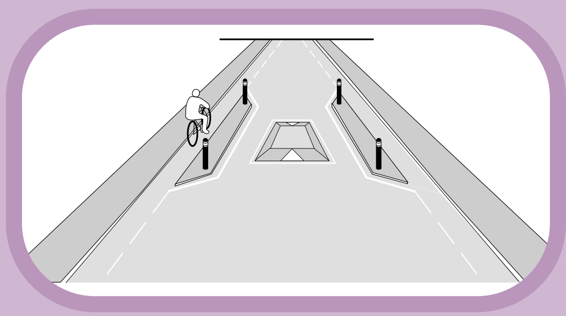


Diagram 6.20 Pinch-point with speed cushion



Design and effectiveness

The tighter a chicane is, the more effective it will be at reducing vehicle speeds. However, chicanes must be designed so that all vehicles allowed to use a particular road can negotiate the chicane. If there are long vehicles using the road then the dimensions will need to be more relaxed to cater for them. Different dimensions will be needed for different types of roads within the overall road hierarchy, taking into account the nature of traffic that they carry. Catering for long vehicles can reduce the effectiveness of chicanes for cars and motorcycles.

It is possible to design many different chicane layouts, but research and advice on the effectiveness of these is limited.

Reducing the field of view for drivers and the optical width of the road using landscaping and street furniture at the measure can help to reduce speeds. Care should be taken that visibility of oncoming traffic and other road users such as pedestrians and cyclists is maintained at a level appropriate to the design speed. Failure to do so may result in other types of accidents.

If planters are used to provide landscaping at build-outs, care should be taken that they do not obscure the visibility of pedestrians (particularly small children) who might cross in that area.

The use of overrun areas (see Chapter 6.10) can improve the effectiveness of chicanes. The overrun areas consist of slightly raised areas of contrasting material such as cobbles. They are laid in such a way as to encourage cars to take a tighter path through the chicane and thereby reduce their speed more. In order to be effective, the overrun strip must be designed in a way that will discourage cars from mounting it. However, long vehicles can mount the overrun area to negotiate the chicane. The overrun area should be conspicuous so that drivers and riders can easily see it. This will encourage them to reduce their speed and take a suitable path through the chicane although motorcycles can often take a relatively straight line through the chicane without reducing their speed.

Speed at Chicanes

Table 6.6 shows the results of a survey of car speeds at a variety of chicanes in the UK. The figures indicate the range of mean and 85%ile speeds at different chicane layouts within the

Diagram 6.21 Two-way working chicane

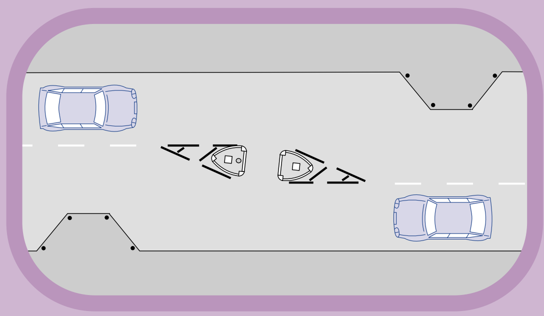


Table 6.6 Speeds at chicanes

TYPE OF CHICANE	Mean speed mph	85% speed mph
Single-lane working	18-23	21-30
Two-way working	21-33	25-38

Table 6.7 Speeds at chicanes

TYPE OF CHICANE	Mean speed mph	85% speed mph
Single-lane working	23	27
Two-way working	31	34

survey. The single-way working chicanes tend to reduce speeds more because they require one direction of traffic to give way to the other (if there is sufficient opposing flow).

Speed between Chicanes

The speed of cars between the chicanes was analysed from the same survey as referred to above, and is shown in Table 6.7.

There is little published information on how speed varies with the spacing of chicanes but it is likely to follow a similar pattern to that for road humps (see Chapter 6.13.1).

Parking

Care is needed with the design of chicanes because parked vehicles on their approaches can obstruct them if not regulated correctly. This can bring the measures into disrepute in areas where parking restrictions are not self-enforcing or where there is pressure for parking spaces. On wider roads or roads which can be narrowed to single-lane working, the chicane can be formed using build-outs to shelter parking. The example in Diagram 6.23 includes ways of accommodating parking.

Accidents[70]

Accidents at a selection of chicane sites in the UK showed an average reduction in injury accidents of 54%. The severity of the accidents occurring was also significantly reduced. However there was an increase in accidents at a small number of the sites.

6.13 Vertical deflections – Ramps, Speed Tables and Speed Cushions

6.13.1 General

Vertical deflections of the carriageway can be designed and constructed in a variety of ways. General advice on design, construction and maintenance issues is given in Chapter 6.14.

Types of feature

Ramps are the most common vertical deflection. Most ramps have either flat or round-top profiles.

Diagram 6.22 Visability at chicanes

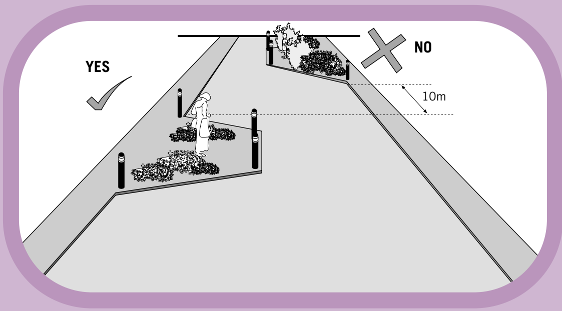
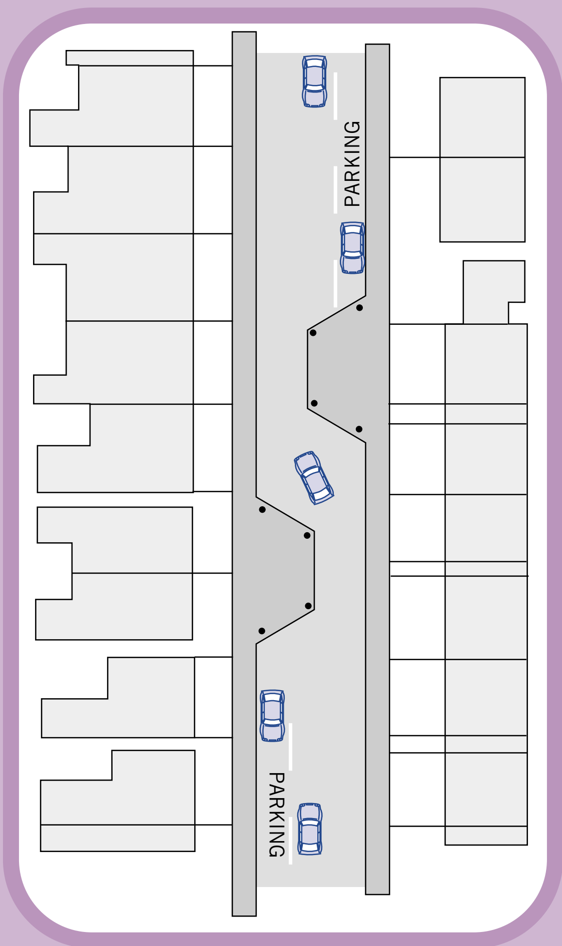


Diagram 6.23 Visability with parking



Ramps can either stretch from kerb to kerb (full width) or their sides can be tapered, finishing before they reach the kerb edge. Flat-top, full width ramps can be useful as places for pedestrians to cross the road. They are particularly useful for people in wheelchairs and those pushing prams, pushchairs etc. It is important that kerb upstands are flush or a maximum of 6mm high if they are to be used as pedestrian crossing points (Section E, Chapter 13). Tapered side ramps allow water to flow around them and therefore do not require the provision of additional drainage, which can save on implementation costs.

"Speed table" is a term used for longer flat-top ramps. When they stretch across a junction they are often termed "table junctions".

"Speed cushions" are a narrower form of ramp that wider vehicles can straddle (or partially straddle).

Size

No minimum or maximum dimensions are currently prescribed for the height, widths and lengths of vertical deflections in Ireland. However, it is important that these features are designed to attain an acceptable balance between the benefits and potential drawbacks outlined in Chapter 6.6. It is the combination of height, length and entry or exit slope (width and side slope for speed cushions) that determines the speed at which vehicles can travel over them.

Most of the ramps constructed on public roads in the UK are at least 3.7m long, to minimise the risk of vehicles grounding on them. This is recommended as good practice in Ireland. Ramps on public roads should not be less than 900mm long.
Details on dimensions of different types of feature are given in subsequent parts of this chapter.

Spacing

Whilst the height and shape of the features influence the speed at the feature, the spacing of features is an important factor in determining the speed between them.

Diagram 6.24 Full width ramp

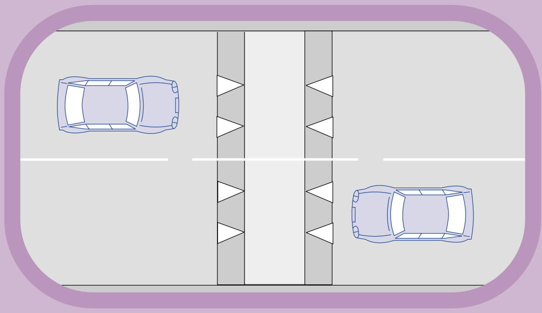


Diagram 6.25 Tapered side ramp

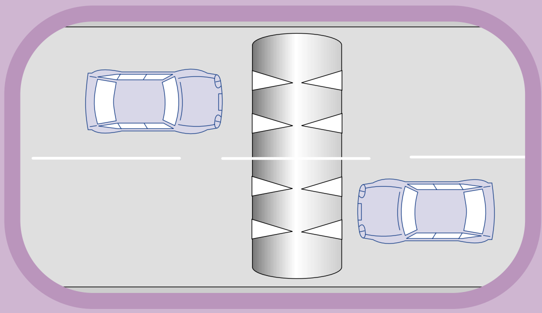
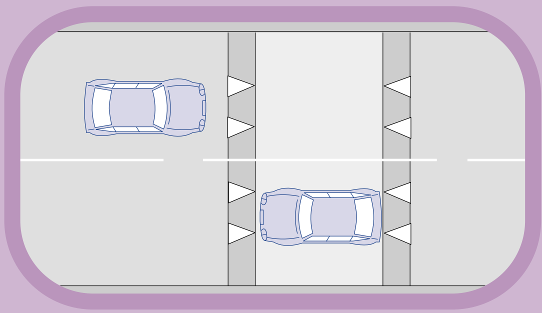


Diagram 6.26 Speed Table



Speed between Ramps

The mean "after" speeds of cars between ramps from a survey of UK traffic calming schemes is shown in Table 6.8.

The design of a traffic calming scheme should aim to minimise accelerating and braking at and between features. It should encourage driving at a constant low speed. Good design practice is to space appropriate features as regularly and frequently as practicable (70m to 100m). Poor design practice is to have features that encourage harsh braking and consequent heavy acceleration in between (severe features or spacing greater than 120m apart).

Location

Where possible, it is advisable to locate the first feature in a system of traffic calming close (40m to 60m) to a point on the road where speeds are already lowered. Such locations include a junction, tight bend etc.[30] Where this is not possible advance signing and gateways or entry treatments (see Chapter 6.9) would help to alert drivers and riders to the need to slow down and take care.

Speed reduction

Research reports[59,69] in the UK have recorded average and 85%ile vehicle speeds on a variety of different vertical deflection schemes. The main results from these will be summarised later in this chapter.

Signing and road markings

It is important that drivers and riders are given adequate warning of vertical features so that they can reduce their speed accordingly.

Clear, conspicuous signs and road markings can help to do this. Signs should be provided in advance of the features and should incorporate a distance plate if appropriate. If the features are greater than 150m apart they should be signed individually. Although there is no prescribed marking to be placed on the features, they should be marked clearly. This can be achieved in a number of ways. In the UK triangular markings are required to be placed on the features. In Holland and Germany a chequer

Diagram 6.27 Speed cushions

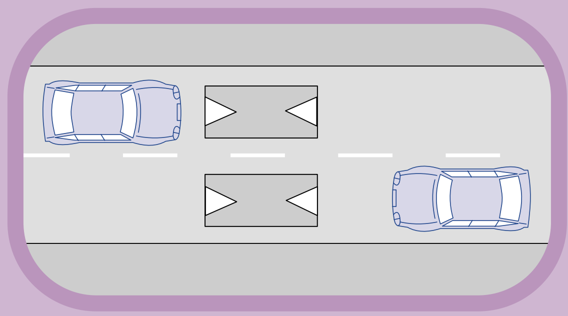
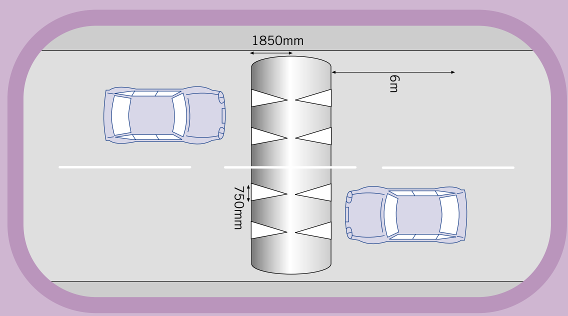


Table 6.8 Mean after speeds of cars (mph) between round-top and flat-top ramps

Mean Before Speed (mph)	RAMP Spacing (m) 60	80	100	120	140
30	19	20	22	23	24
35	21	22	24	25	26

Diagram 6.28 Recommended road markings for Ramps



marking is commonly used across the whole width of the measure. In Ireland a variety of markings have been used in recent years. It is the responsibility of each road authority to satisfy itself that the markings used are clear and unambiguous. The signs and markings should be positioned so that parked vehicles do not obscure their visibility.

The markings indicated in Diagrams 6.28 and 6.29 are recommended for use on ramps and speed tables. The offside markings are provided in case parked vehicles obscure the nearside ones but should be omitted if traffic is directed (for example by a keep left arrow at a refuge) to proceed across a particular part of a ramp only (see Diagram 6.36).

For speed cushions, a different marking is recommended (see also Chapter 6.13.6). The markings should be included on both sides of the cushion if parked vehicles are likely to obscure one of the cushions.

6.13.2 Round-top ramps

Round-top ramps have the cross-section of a segment of a circle. The height of the ramp referred to is the maximum height in the centre. Most of the round-top ramps that have been constructed on the public road in the UK are 3.7m long and between 50mm and 100mm high. Shorter ramps have been tried but it is more difficult to get an acceptable balance between speed reduction and some of the potential drawbacks. Diagrams 6.31 and 6.32 show typical details of the construction of a round-top ramp.

The 3.7m length is designed to minimise the risk of vehicles grounding on them. However, some vehicles have a lower suspension and other vehicles such as funeral cars have a longer wheelbase, without the extra ground clearance of a bus or emergency service vehicle. In such instances they can ground even at low speeds. Round-top ramps are generally constructed with tapered sides because they are not suitable places to encourage pedestrians to cross.

100mm high round-top ramps may result in vehicles grounding on them and also tend to be criticised by a larger proportion of drivers as being too severe and exacerbating the potential drawbacks such as discomfort, noise, vehicle damage etc. 50mm

Diagram 6.29 Recommended road markings for Speed Tables

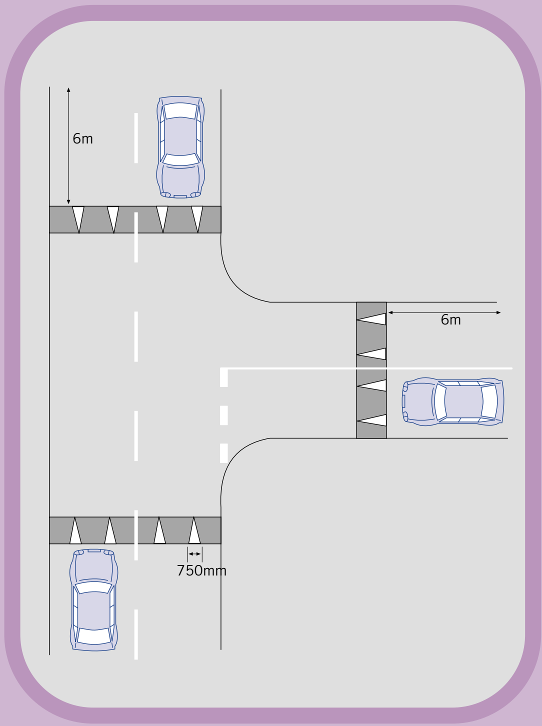


Diagram 6.30 Recommended road markings for Speed Cushions

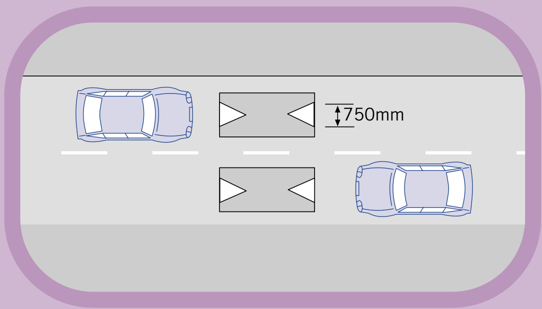


Table 6.9 Speed of cars at 75mm high round-top ramp

MEAN SPEED (mph)	85% SPEED (mph)
15	19

high round-top ramps are generally perceived as allowing too many vehicles to travel too fast over them and not effective enough for most areas. They can also exacerbate the noise of lorries. There are some exceptions to this e.g. on gradients steeper than 1 in 10.

75mm high round-top ramps represent a good balance between reducing vehicle speeds and some of the adverse impact of the measures as outlined in Chapter 6.6. Table 6.9 indicates the results of a survey of car speeds at 75mm round-top ramps in the UK.[59]

The same report also indicated that there was only 1mph difference in the mean crossing speed for 75mm and 100mm high ramps.

6.13.3 Flat-top ramps and speed tables

Flat-top ramps consist of a raised section of carriageway with inclined sections (entry/exit slopes) at either end. Most of the flat-top ramps constructed on the public road in the UK have a minimum flat-top length of between 2.5m and 3m (excluding entry/exit slopes). Shorter lengths could lead to vehicles grounding. Entry/exit slopes vary in gradient between 1 in 6 and 1 in 30. The height of features varies between 50mm and 100mm. Heights greater than 100mm are not allowed in the UK. Diagram 6.33 and 6.34 show typical details of the construction of a flat-top ramp.

The height of flat-top ramps and speed tables, is less critical than with round-top ramps because the entry/exit slope and length of the feature are also significant factors in the design. Table 6.10 indicates the results of a survey of car speeds at 75mm flat-top ramps in the UK.[59]

Entry/exit slopes steeper than 1 in 10 are little used as they are generally considered to be too severe. Slopes of 1 in 20 and shallower tend to be ineffective in terms of reducing speeds. Increasing the length of the flat-top is often favoured by bus operators and emergency services, as they perceive it to reduce the discomfort for drivers and passengers together with maintenance and repair costs for their vehicles.

Diagram 6.31 Plan view of round-top ramp

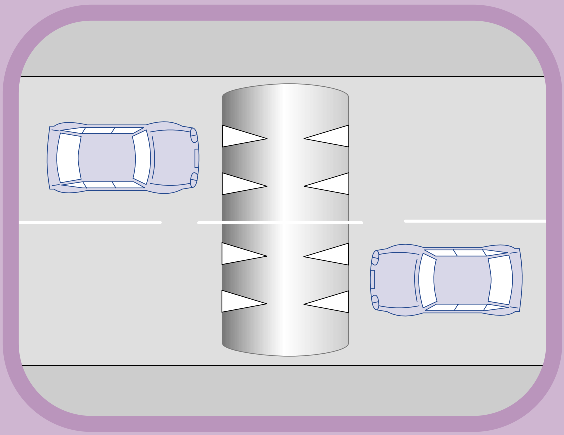


Diagram 6.32 Cross section of 75mm high round-top ramp

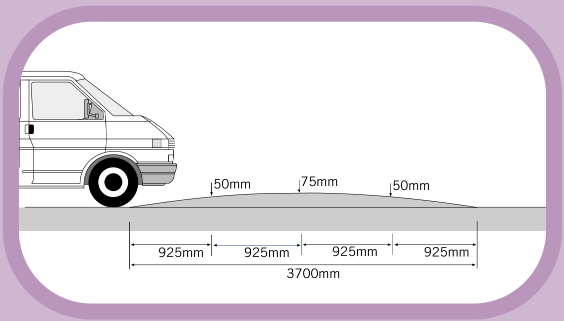


Table 6.10 Speed of cars at 75mph high flat-top ramp

ENTRY/EXIT slope	MEAN SPEED mph	85% SPEED mph
1:10	12	14
1:15	13	16
1:20	16	21
1:25	26	30

A minimum flat-top length of 2.5m (6m on bus routes), a height of 75mm together with ramp slopes of 1 in 15 represents a good balance between effective speed reduction and the potential drawbacks.

Speed tables tend to be located on more sensitive traffic routes, usually in response to bus or emergency service concerns. They have the advantage that they can be positioned at junctions. Because they are longer, the pitching movements associated with shorter ramps are not as pronounced and passenger comfort is generally improved. Mean vehicle speeds increase by around 1mph for each extra 6m length (up to 18m), when compared to standard 2.5m to 3m flat-top lengths. Where speed tables are located at junctions, it is common practice to extend the feature into the side road by around 6m to allow a car to wait with all four wheels on the raised area. Diagram 6.35 shows a typical speed table layout at a junction.

Pedestrian crossing points

Full road width flat-top ramps can be used in conjunction with both controlled (including zebra crossings) and uncontrolled pedestrian crossing points to create safer crossing locations. However, care needs to be taken at uncontrolled crossing points that the appearance of the ramp (surface finishes etc.) does not give pedestrians the impression that they have an increased level of priority. Chapter 13 gives details on the use of tactile paving at such crossings. In some areas of the UK there have been reports of problems with pedestrians walking out into streams of traffic and expecting drivers to stop as they would at a controlled crossing point.

Reducing passenger discomfort

Discomfort for drivers/passengers is one of the main drawbacks with ramps. The driving style adopted by the majority of drivers at these features is to reduce their speed on approach and to accelerate once the front wheels of the vehicle have cleared the ramp. Most of the discomfort is therefore experienced as the rear wheels traverse the feature. At certain locations (such as one-way streets or where the ramp can be constructed with a refuge island), it is possible to reduce the discomfort without compromising the desired speed reducing effect. This can be achieved by reducing the exit gradient of the ramp to around 1 in 30, whilst maintaining the entry gradient at 1 in 15 (see Diagram 6.36).

Diagram 6.33 Plan view of flat-top ramp

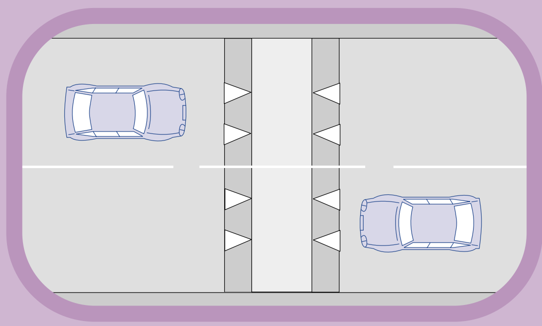


Diagram 6.34 Cross section of 75mm high flat-top ramp

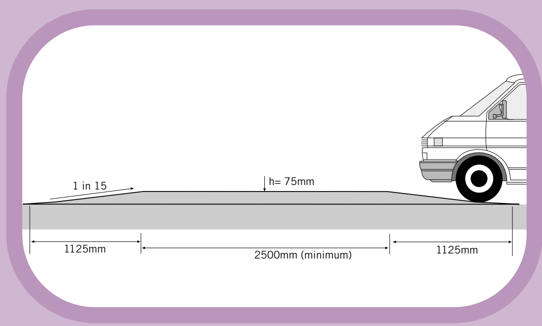
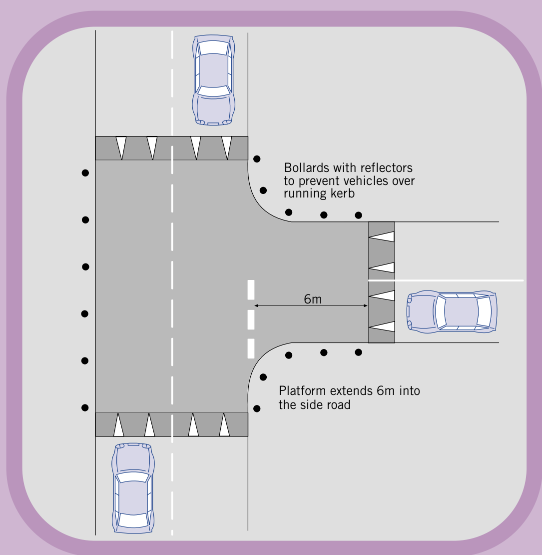


Diagram 6.35 Speed table layout at junction



Other types of vertical measure

There are a variety of other types of vertical measures that have been tried. Some of these are listed below with references for further reading. These features are not in widespread use but may have some limited applications in Ireland.

- Sinusoidal ramps[31,71] – These aim to improve ride quality for cyclists but their effect is comparatively small and they are difficult to construct.
- "H" and "S" ramps[31,71] – These aim to improve the ride quality for wider vehicles such as buses and emergency service vehicles. They are more difficult and costly to construct. Speed cushions and speed tables can produce similar benefits.

6.13.6 Speed Cushions[17,30,69]

"Speed cushions" are narrow versions of ramps that wider vehicles can straddle (or partially straddle), thereby reducing some of the potential drawbacks of traffic calming on buses, fire engines and lorries. The concept originates from Germany where they are widely used to great effect.

Application in Ireland

The way buses are constructed in Ireland reduces some of the potential benefits of speed cushions. In Germany, some large vehicles have a single wheel at each end of the rear axle; this gives them a much wider inner wheel track width than cars. In Ireland and the UK, larger vehicles have a double wheel combination on each end of the rear axle. This reduces the inner wheel track width to be much closer to that of a car (see Diagram 6.37).

Despite this, cushions are in widespread use in the UK, particularly on bus routes. They are also in use in Ireland.

Compared to 75mm high round and flat-top ramps, speed cushions can offer benefits for buses and other wider vehicles. They do however allow cars to travel faster (depending on the design of cushion used) and therefore may not be suitable for areas where speeds of 20mph or lower are required. They tend to be more popular with bus operators and can be considered for use on bus routes where appropriate.

Diagram 6.36 75mm high flat top ramp with different entry/exit gradients

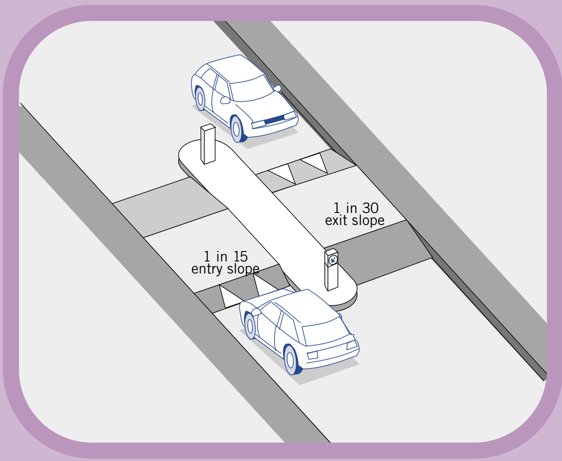
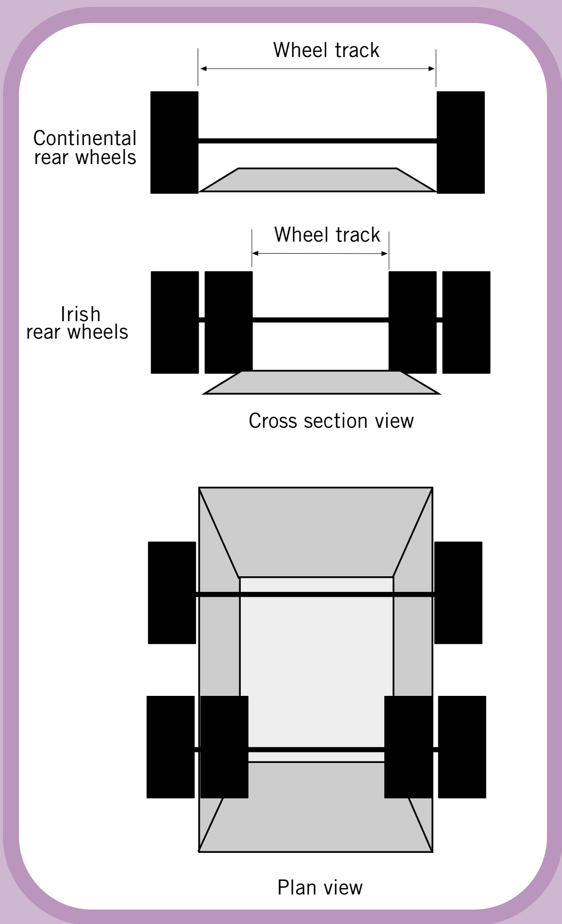


Diagram 6.37 Wheel track widths



Signing and road markings

Speed cushions can be signed in the same way as other vertical deflections. However because they are narrower, they are more difficult for drivers to see. In addition to the customary triangular markings, the use of a solid edge line around them can help to highlight them to drivers and aid speed reduction (see typical layouts).

Driver and rider behaviour

At speed cushions, some drivers will attempt to drive in the gaps, or drive with only one side of the vehicle on the cushion. If the lateral gap between adjacent cushions is too wide then it will become attractive for vehicles to drive through this rather than attempt to straddle the cushion. If the gap is too narrow then there is an increased risk of vehicles colliding with each other while negotiating the cushions.

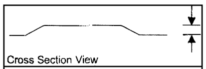
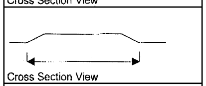
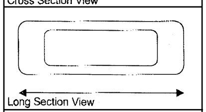
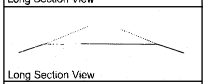
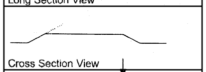
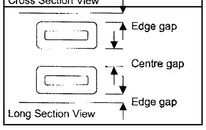
CUSHION DIMENSION	ILLUSTRATION	MINIMUM/MAXIMUM DIMENSIONS	COMMENTS
Height		65mm–75mm	Vehicles can ground more easily on narrow cushions
Width Edge to edge		1.5m–1.9m	Wider cushions tend to reduce car speeds more
Length		2.5m–3.5m	Longer cushions may be more comfortable
Entry/Exit Slope		1 in 8 max.	
Side slope		1 in 4 max.	
Transverse gaps		0.75m min at edge 1 to 1.2m max at edge or between adjacent cushions	Minimum edge gap for cyclists Maximum gap needed to minimise the number of vehicles using gap to avoid the cushion

Table 6.11 Practical minimum and maximum dimensions for speed cushions[69]

APPROXIMATE SPEEDS AT CUSHION (MPH)					
Cushion width (mm)	1,500	1,600	1,700	1,800	1,900
Mean speed (mph)	21	19	18	17	16
85% speed (mph)	28	26	24	22	20

Table 6.12 Speed of cushions of different widths (75mm high, 1:8 entry/exit slope, 1:4 side slope)[69]

APPROXIMATE SPEED BETWEEN CUSHION (MPH)					
Distance between (m)	60	70	80	90	100
Mean speed	21	22	23	24	25
85% speed	24	26	27	29	30

Table 6.13 Speeds between adjacent sets of cushions at different spacings[69]

Motor cycles can negotiate some speed cushion schemes without reducing speed significantly by using the gaps between them.

Design of Speed Cushions

Care needs to be taken with the design of speed cushions if they are to strike the desired balance between general speed reduction for cars (and powered two-wheelers) and mitigating the adverse effects for buses and emergency service vehicles. The dimensions are critical and need to be considered carefully in conjunction with the type of buses, ambulances and fire service vehicles using the route to be treated.

The dimensions given in Table 6.11 are recommended as practical minimum and maximum dimensions for speed cushions.

Table 6.12 below shows the results of a survey of car speeds at speed cushions of different widths in the UK.[69]

The spacing of sets of cushions will have a strong influence on vehicle speeds between them. Table 6.13 indicates the results of a survey of speeds between speed cushions in the UK.[69]
For situations where there is regular use by smaller buses/ambulances, 1600mm wide cushions can be used. These offer a good balance between improved passenger comfort and general speed reduction but they also allow cars to travel faster.

Wider cushions (1800mm–1900mm) may be appropriate on roads where larger buses operate and which are not main routes for ambulances.

It is recommended that discussions take place between roads authorities, emergency services, public transport operators and bodies representing goods vehicles interests (if appropriate) to discuss the types of measures to be used on more traffic sensitive routes.

Typical layouts

Cushions are often used in one of the following configurations.

- Single cushion with single-way pinch-points (controlled by yield markings). These are suitable for roads with flows between 3,000 and 7,000 vehicles per day and can accommodate parked vehicles (see Diagram 6.38).

Diagram 6.38 Single Cushion layout

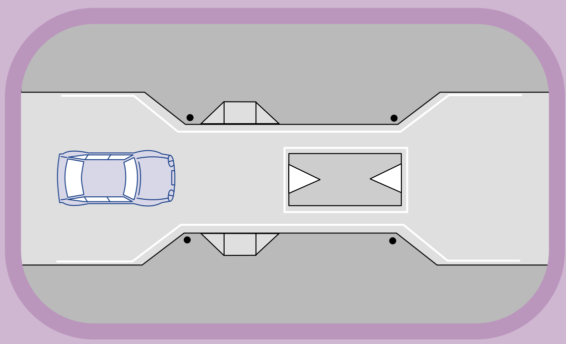


Diagram 6.39 Two cushion layout

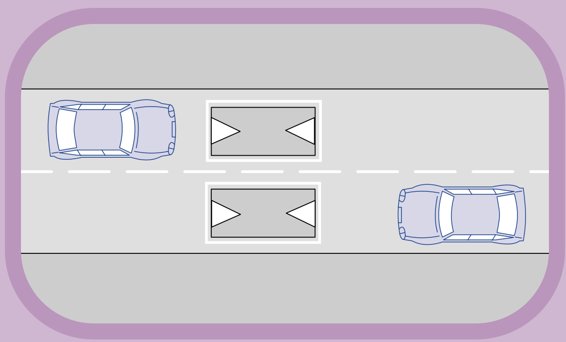
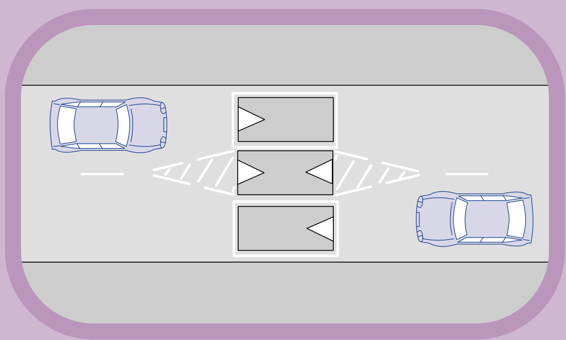


Diagram 6.40 Three cushion layout



- Pairs of cushions – allow two-way working but care is needed with the central gap (1.2m max). These are suitable for roads 5.5m–6.5m wide or where local narrowing is needed (see Diagram 6.39).
- Three abreast cushions – these are suitable for wider roads (7.3m–8.5m) and roads with parking which would obstruct the correct use of pairs (see Diagram 6.40).

The most appropriate configuration for a speed cushion layout will depend on the width of cushion used, the width of edge and centre gaps, and the available road width. It may be necessary to narrow or widen a road locally to ensure that the cushions fit the available road width and the recommended gaps are not exceeded (see Diagram 6.41).

On roads carrying significant volumes of buses or trucks, consideration should be given to using traffic islands to channelise the opposing flows. In this case, if the island is likely to be used by pedestrians, then the cushions should be staggered slightly from the islands so that they are not a trip hazard (see Diagram 6.42).

Where the road width prohibits the use of islands, then white line hatching (sometimes with a third cushion in it) can be used as an alternative to an island (see Diagram 6.40).

Parking on the approaches and exits from cushions can prevent vehicles from straddling them and negate the intended benefits. Due consideration needs to be given to parking at the design stage and appropriate measures taken to prevent this if it would cause problems for bus operators or emergency services (see Diagram 6.43).

6.14 General design, construction and maintenance issues

Design

A wide range of traffic calming features is described in detail in this chapter. Road authorities should use a range of appropriate measures on each scheme rather than rely solely on one feature such as ramps. Throughout the selection and design process of

Diagram 6.41 Cushions with road narrowing

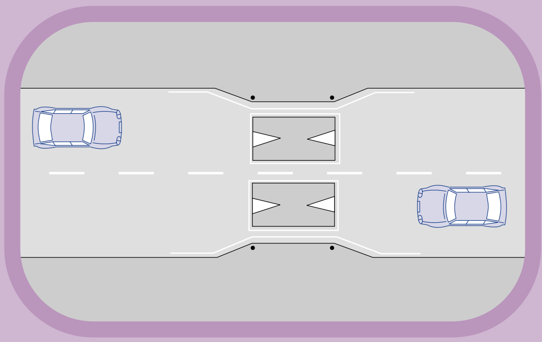


Diagram 6.42 Cushions with island

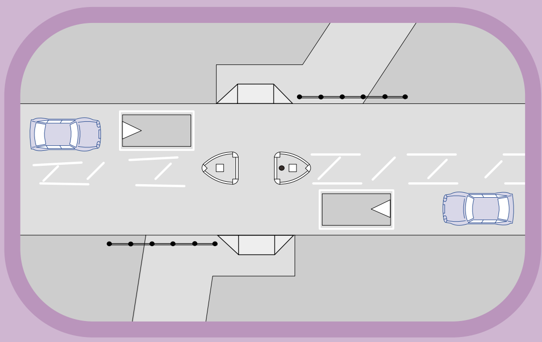
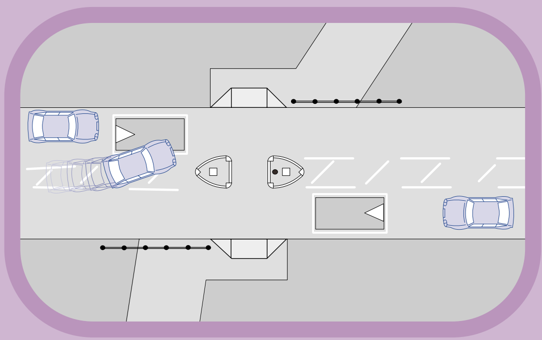


Diagram 6.43 Parking obstructing correct use of cushion



traffic calming features, it is necessary to consider a number of issues. It is very important that the materials used are of high quality and that the construction of the features is to a high standard. The opportunity to enhance measures through the use of hard and soft landscaping should be taken wherever possible. The advice of landscape architects should be sought where appropriate.

Build-outs to form chicane offering scope for landscaping

Location of features

When locating traffic calming features on a road, consideration must be given to a number of operational requirements:

- Turning movements into and out of junctions and private accesses will need to be maintained.
- Safe access to manholes, access chambers and service covers will be needed. Positioning a traffic calming feature near one may require a temporary road closure and signed diversion route before they can be accessed.
- Routine maintenance activities such as gully cleaning, channel sweeping and lamp replacement must be catered for.

Series of ramps

Signs and road markings

Signs and road markings warning drivers of the presence of traffic calming schemes are required. These should be located so that drivers approaching the measures can see them clearly and do not have to brake suddenly. Signs should be positioned so that visibility of them is not obscured, e.g. by parked vehicles. More detailed advice is given in the previous sections on different types of traffic calming feature.

Lighting of measures

Parking

Some traffic calming measures such as chicanes and road narrowings require the removal of parking spaces to operate effectively unless schemes are designed specifically to cater for parking (see Diagram 6.44). In built-up areas, parking can be a very sensitive issue and it needs to be addressed at the early stages of a design. The careful design and selection of features can often minimise potential problems.

Lighting

Illumination of the features in the dark should enable road users to see the features clearly. It is important for road users to be able to see their path through the deflection. Overrun areas must be clearly distinguishable both in daylight and night-time conditions. Improvements to existing lighting should be considered as part of the scheme design process. Lighting in accordance with BS 5489 should be provided along the whole of the traffic calmed road where possible. If this is not possible then the measures should be individually lit to this standard. Assistance should be sought from an experienced street lighting engineer on these matters.

Cyclists

Traffic calmed streets are a more attractive environment for cyclists because of the reduction in the dominance of motor vehicles. Traffic calming schemes reduce the speed of vehicles to a level that is closer to the speed of cyclists. Schemes do however need to be designed to meet cyclists' needs and should not put them at greater risk by putting them in conflict with vehicles at features such as road narrowings and chicanes. Cyclists can feel threatened if they are "squeezed" by motor vehicles, so where possible cycle bypasses should be provided. These are short segregated alternative routes, which allow cyclists to pass horizontal traffic calming measures separately from vehicular traffic (see Chapter 6.12). It is important that cycle tracks and other facilities are adequately maintained, as the general flow of traffic will not clear them of stones and detritus. If cycle tracks are not regularly swept cyclists will not use them.

Traffic diversion[62]

Studies in the UK have shown that it is common for traffic to divert from traffic calmed roads onto alternative routes. An average reduction in traffic of 25% was recorded in a survey of traffic calming schemes. Factors such as the availability of convenient alternative routes influence the actual level of usage. Care should be taken that traffic is diverted onto appropriate main roads rather than onto adjacent residential streets (as in Diagram 6.46).

Landscaping and enhancement

Traffic calming schemes (particularly those where road narrowings provide more space) offer the opportunity to

Diagram 6.44 Chicane with parking facilities

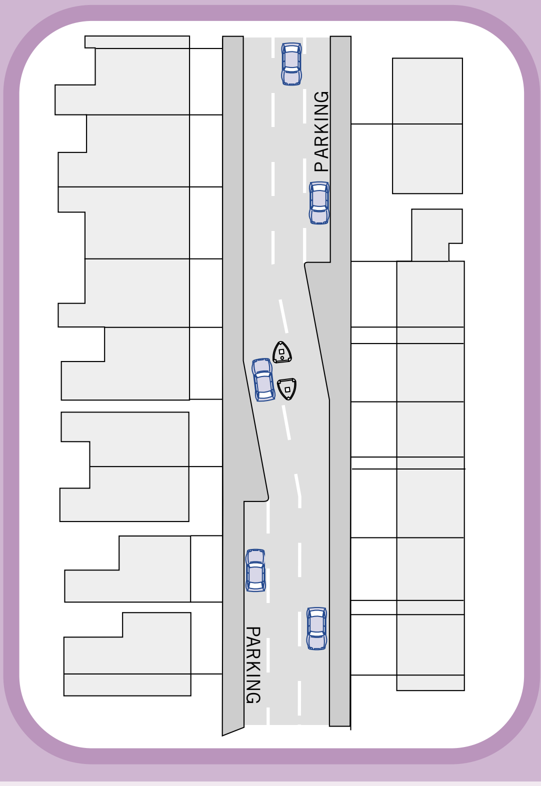
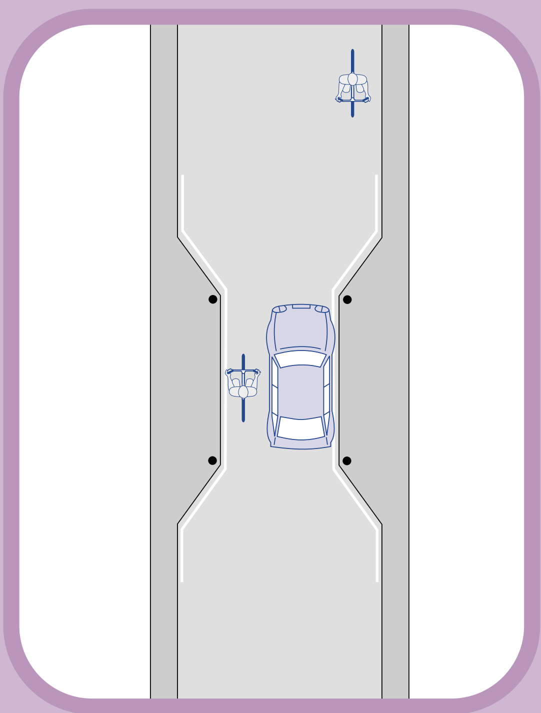


Diagram 6.45 Cyclist squeezed by car at road narrowing



incorporate hard and soft landscaping into schemes. Whilst it is common practice to provide planters for this purpose, they are not always appropriate and their maintenance needs to be considered so that they do not become overgrown. Similarly, lack of attention may result in planters falling into disrepair or the plants dying. Permanent planting options should be considered where possible. "Guidelines on traffic calming for towns and villages on national routes, 1999[88]" published by the NRA gives advice on these issues and where possible an experienced landscape architect should be consulted.

Noise[25, 57,76]

General traffic noise levels are likely to reduce in traffic calmed areas due mainly to either a reduction in the volume of traffic or tyre noise. However, there may be localised problems with noise from vehicles braking and accelerating and truck body/load rattle. The latter is most associated with vertical deflections.

Air quality[57,67,75]

Most studies have found that vehicle emissions are reduced in traffic calmed areas, principally through the reduced volume of traffic. Air quality can be difficult to assess as it depends on prevailing atmospheric conditions. At lower speeds some pollutants increase and others decrease. A scheme that promotes uniform driving speeds and discourages harsh acceleration and deceleration is likely to be of least detrimental impact in terms of air quality.

Construction materials and maintenance issues

Asphalt and bituminous macadam

Asphalt and bituminous macadam are the most commonly used construction materials. They are smooth, flexible and are generally cheap to lay and maintain. They can be pigmented to provide different colours but this increases the costs of installation and also maintenance (as the colour fades in a comparatively short time). Tyre marks and fuel spillage on the running lanes also discolour the surface. Like all surfacing materials, the correct specification needs to be chosen to reduce deformation problems such as wheel track rutting.

Diagram 6.46 Traffic diverting along adjacent residential route

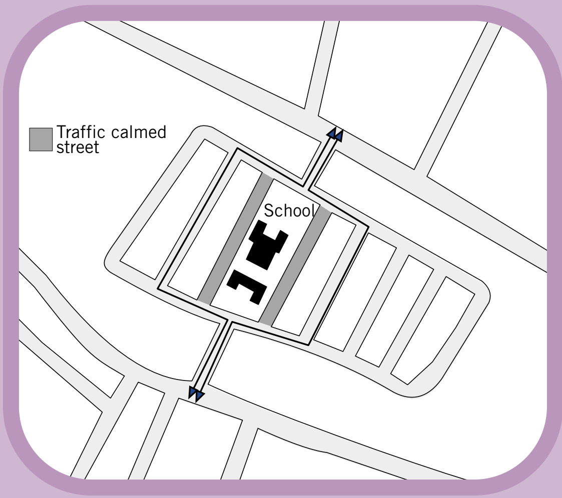
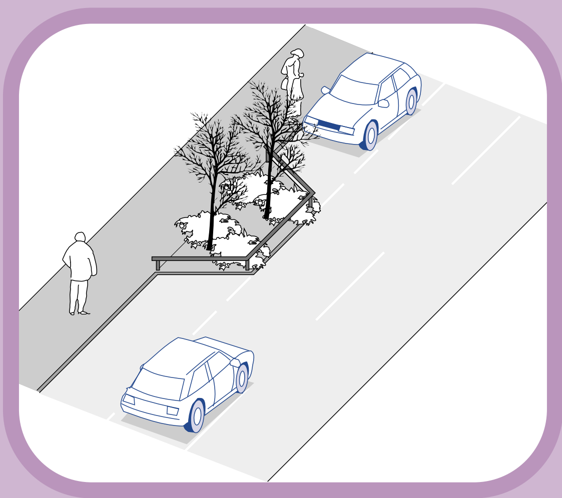


Diagram 6.47 Built-out to provide area for landscaping



Blocks

Blocks such as concrete blocks and clay pavers are used to provide enhancement and improve the aesthetics of features. The clay pavers provide better colour retention than concrete blocks but can polish and be slippery when wet and should not generally be used in areas where braking or turning movements take place. Blocks with a natural colour and irregular surface finish do not discolour as noticeably in running lanes. Their rougher surface texture and appearance enhance the speed reduction effect. Materials that easily polish (such as granite) should not be used in running lanes except at very low speeds or away from braking and turning areas.

Designers should exercise considerable caution before deciding on the use of block pavers in ramps.

Block pavers should not be used in the following situations:

- where traffic speeds are high
- where they will be subjected to a high number of turning movements by heavy goods vehicles
- where road gradients are high

Blocks are traditionally laid on a bed of sand. Whilst this generally works well in pedestrian areas, the forces imparted by vehicles on ramps has led to problems with the blocks becoming loose and dislodged into the road. The problems are compounded by mechanical channel sweepers, which can suck up the sand from joints and weaken their structural integrity. Some of these problems can be eradicated by setting the blocks in a mortar mix and mortaring the joints. An experienced materials engineer should be consulted over specifications for the mix to minimise future maintenance problems. Thermoplastic paint markings (often used to highlight the presence of features such as ramps) do not adhere well to blocks because the blocks can move individually. This leads to the thermoplastic breaking up and being removed by the action of traffic.

Composite constructions

Care is needed when vertical deflections use a combination of materials such as asphalt slopes and block-work tops. Asphalt is a flexible material and blocks are more rigid. This can lead to differential movement between the two materials with the asphalt compressing particularly in the wheel tracks. This can

Asphalt ramp

Block ramps deformed

leave a "lip" between the two materials, which can exacerbate noise or form a potential hazard for two-wheeled vehicles. The existing road may have some deformation in the wheel tracks, which could increase the effective height of the ramps. When constructing vertical deflections, it may be necessary to re-profile the immediate approaches to the ramp to reduce this effect.

Ramp with composite construction and ‘lip’ between materials

Other materials

A variety of other materials such as rubber and concrete sections can be used to construct traffic calming features and are available as proprietary products from manufacturers.

One of the systems involves the use of a hot applied bitumen based compound between 10mm and 25mm thick. A pattern can be pressed into it to create a ‘blockwork’ effect. It can be provided in a variety of colours and can accommodate thermoplastic road markings.

Bitumen based material with block pattern

The potential advantage that the system offers is the appearance of a high quality block work surface without the maintenance problems associated with blocks.

These materials are relatively new so little is known about their longer term durability.

Drainage

Additional drainage gullies may need to be provided for some traffic calming measures such as:

- full width ramps and speed tables
- build-outs, pinch-point and chicanes

This is because they can interfere with the flow of rainwater and cause localised ponding. Care should be taken that the gullies are positioned at low spots and that they are not positioned at locations where pedestrians cross. The gratings used should be cycle friendly.

Strengthening of existing road

Where traffic calming features are placed on existing roads they can change the path that vehicles take and the loading conditions for the road. This can cause localised failure of the road surface if it is not in good condition and lead to criticism of the scheme. Prior to the installation of any horizontal or vertical traffic calming measure, consideration should be given to the condition of the existing road and the carriageway should be strengthened as part of the works if appropriate.

Routine maintenance

Traffic calming measures such as chicane and road narrowings may need additional routine maintenance such as channel sweeping and litter collection. This is because road detritus can accumulate in narrower channels, which are not trafficked by motor vehicles and could discourage cyclists from using features such as cycle by-passes specifically provided for them.

6.15 References

DEPARTMENT OF TRANSPORT CIRCULAR ROADS
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7

chapter 7 Traffic Calming for New Residential Roads

7.1 Philosophy of speed restraint on new roads

Historically, many residential roads were not designed to cope with the volume and parking requirements of the present day levels of traffic. Consequently they often have accident problems. Even recently built roads in housing areas do little to limit the speed at which vehicles can be driven along them. Their alignment is often straight or flowing and the carriageway is wider than necessary. This encourages driving speeds well in excess of the 30mph legal speed limit. As a result, residents are concerned about safety and this leads to requests for traffic calming measures such as ramps.

It has been common practice (for many years) in some European countries, to design residential areas to physically limit vehicle speeds to 30kph or 20mph. Chapter 5 illustrates how achieving lower speeds can reduce the number of accidents and increase the feeling of safety. Chapter 6 outlines the use of a wide variety of traffic calming techniques to reduce vehicle speed and improve safety where there are problems on existing roads.

On new roads however it is possible to constrain speeds without the need to resort to crude remedial treatments such as ramps. The opportunity exists to use horizontal alignment constraints backed up by good urban design to keep speeds low. The careful positioning of buildings, landscaping and the use of different materials can help to reinforce the need to reduce speed and reduce the dominance of motor vehicles.

It is possible to integrate such traffic calming measures with the sustainable development philosophy, and provide safer more attractive places for people to live.

On new roads, vertical deflections should be a last resort where site constraints give no opportunity for other methods of keeping speeds low. Speed tables and speed cushions should only be used in these exceptional circumstances. It should not be necessary to use ramps on new roads and mini-roundabouts are not recommended in new residential layouts.

Diagram 7.1 New road calmed by horizontol layout constraint

Table 7.1 Spacing between speed restraint measures

ROAD TYPE	LOCAL COLLECTOR	ACCESS
Design speed (mph)	30	20
Spacing of measures (m)	100 - 120	60 - 80

Access roads in new residential areas should be designed to physically constrain vehicle speeds to 20 mph. Carriageway width should not exceed 5 metres. Where appropriate, indented visitor car parking should be provided.

Local Collector roads in new residential areas should be designed to physically constrain speeds to 30 mph (see Section A, Chapter 1.7). Carriageway width should not exceed 6 metres. However additional width will be required where provision must be made for on-road cycle tracks or indented car parking. The design of the roads should be pedestrian and cycle friendly.

Speed restraint measures should not have the appearance of an afterthought or remedial treatment.

7.2 Speed restraint measures

It is important that the speed restraint measures used on new residential roads are integrated with the appearance of the development. High quality materials, in keeping with the local area, should be used and the measures should be landscaped. The measures should not have the appearance of an afterthought or remedial treatment.

This chapter looks at a range of measures that are appropriate for new roads. Ramps are not recommended. Speed Tables and Speed Cushions should only be used where site constraints give no opportunity for other methods of keeping speeds low. Long straight lengths of road should be avoided. Table 7.2 outlines the common methods of traffic calming for new residential developments and indicates the appropriate road types for their use. The list is illustrative and is not intended to preclude other appropriate measures, which should be judged on their own merits.

Table 7.2

SPEED RESTRAINT MEASURE	LOCAL COLLECTOR	ACCESS ROAD MAJOR	ACCESS ROAD MINOR
Entry treatment	✗	✓	✓
Shared surface	✗	✗	✓
Carriageway narrowings and chicanes	✗	✓	✓
Speed reduction bend	✓	✓	✓
Speed control island	✓	✓	✓
Change of priority at junction	✗	✓	✓
Traffic island	✓	✓	✗
Speed table/cushion (exceptional circumstances only)	✗	✓	✗

In order to keep speeds low the features should be spaced regularly. The recommended spacings between features (based on monitoring of existing roads) are shown in Table 7.1.

Entry treatment – This marks the change from one type of road to another to make drivers aware of a change in the nature of the road. Typically this would be where a driver turns off the "Local Collector" road onto an "Access" road or from a major access road to a minor one with a shared surface.

Shared surface – This is where a road does not have a separate footway. These can serve up to 50 dwellings and may need further calming features if longer than 80m. The minimum width of the road should be 4.8m but may require widening on bends. The road surface finish should contrast visually and texturally with other conventional access roads so that drivers do not assume precedence.

Carriageway narrowings and chicanes – These can be achieved in a variety of ways and some illustrations are shown below. Care should be taken that pedestrians, cyclists and other vehicles are not masked by any of the landscaping associated with the measure. A vehicle may be required to give way to an opposing vehicle.

Speed reduction bend – Bends in the horizontal alignment can help to reduce speed if they are sufficiently "tight". This requires specifying a maximum radius and angle of turn for appropriate speeds. Adequate forward visibility (33m for 20mph and 50m for 30mph) for the design speed should be maintained around the bends. It may be necessary to provide widening in an overrun material on the bends (see Diagrams 7.4 and 7.5).

Speed control island – These involve lateral shifts of the carriageway and can incorporate the provision of overrun areas or "mountable shoulders" (see Diagrams 7.6 and 7.7). Smaller vehicles slow down and follow the deflection created by the central island. Longer vehicles can mount the overrun areas to negotiate the measure slowly without mounting the footway. Speed control islands are not roundabouts and should not be used at junctions. If used on bus routes the overrun areas may be omitted.

Entry treatment into an Access road

Shared surface access sympathetic to new housing with high quality finishes

Diagram 7.2 Pinch-point reinforced by position of buildings

Priority Junctions – Drivers slow down when turning or yielding right of way at junctions. The careful positioning of priority junctions can assist in restraining speed along a length of road (see Diagram 7.8). Crossroads layouts are not recommended.

The priority at a junction can be changed to act as a speed reducing measure. This is illustrated in Diagram 7.9.

On roads with a relatively low traffic flow (such as access roads), the priority at a junction can be changed to slow traffic down. Diagram 7.9 shows a layout where priority has been changed by creating an offset in the main alignment and giving priority to traffic coming to and from what would traditionally have been regarded as the side road. It is important that approach speeds are low and that visibility for all turning movements is adequate.

Traffic islands – These can be useful facilities where pedestrians and cyclists cross local major access roads and district collector roads. They can help to promote the use of cycle tracks and pedestrian links.

Diagram 7.3 Examples of narrowing at a location where pedestrians may cross

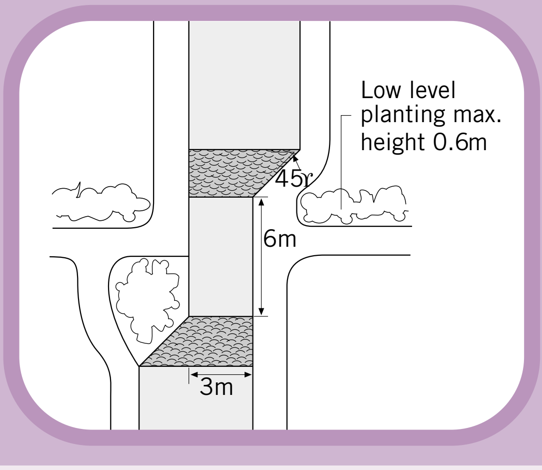

Diagram 7.4 Double speed control bend

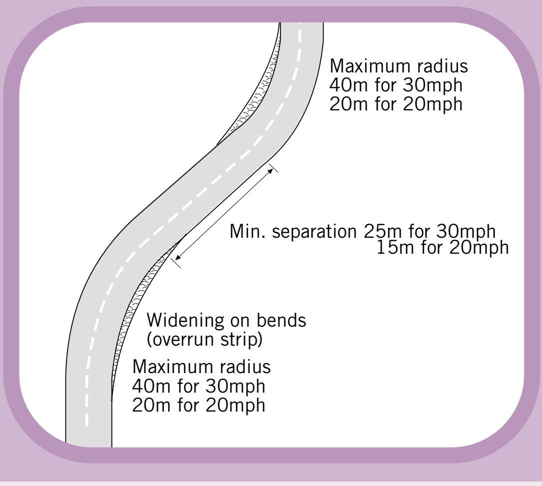

Diagram 7.5 Single speed control bend

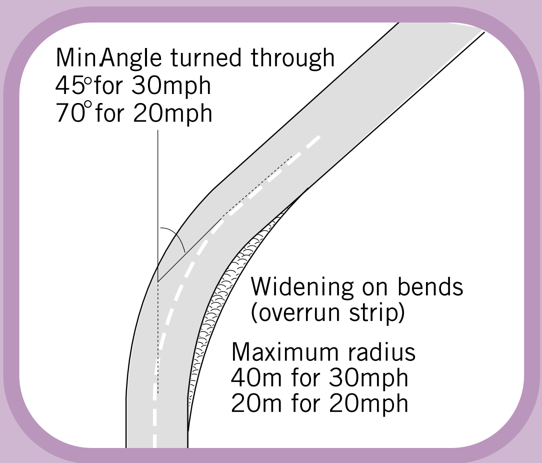

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Diagram 7.6 Speed control island 20mph

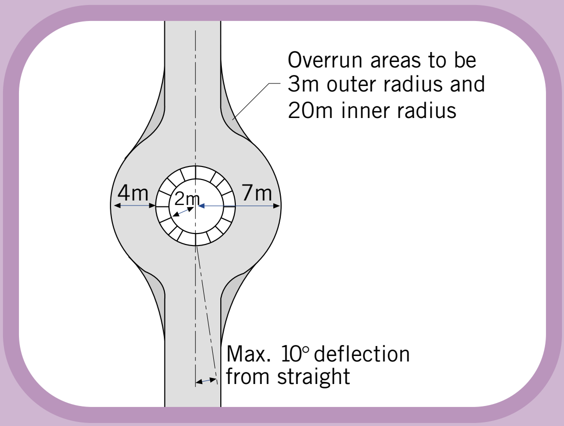

Diagram 7.7 Speed control island 30mph

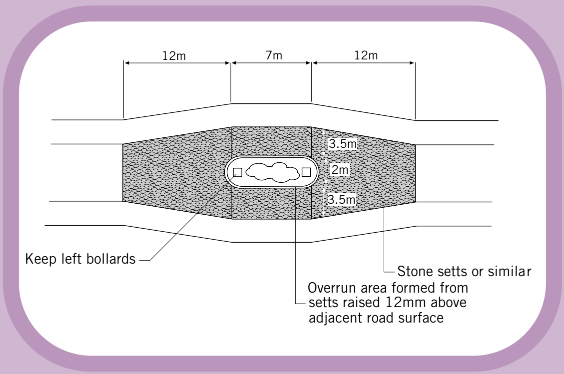

Diagram 7.8 Location of priority junctions

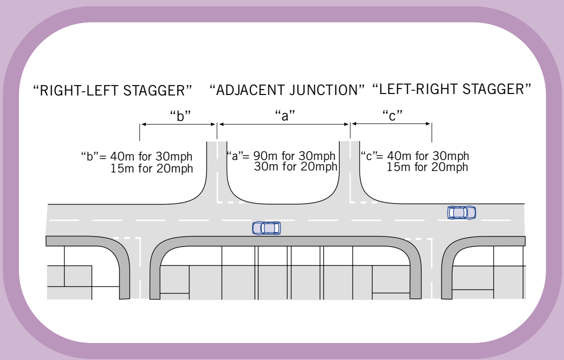

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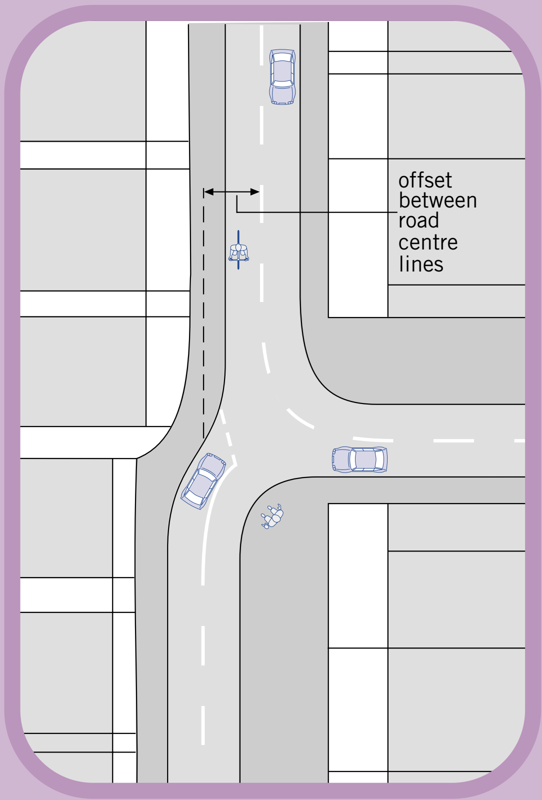
Diagram 7.9 Change of priority junction at a junction



d

section d Junctions

8

chapter 8 General

8.1 Introduction

Junctions are one of the most important elements of a highway network. They determine and control the network's capacity. As they are the point of conflicting movements, they are historically the most likely location of accidents.

The main purpose of a junction is to facilitate the safe transfer of road users from different directions including the safe movement of vulnerable road users.

Over half of all injury accidents occur in built up areas with more than 40% of these occurring at junctions. There is a strong correlation between the number of junctions and accesses on a road and the number of traffic accidents that occur. Therefore it is important that junction designers have a thorough understanding of the safety issues as well as capacity and environmental issues.

8.2 Selecting the appropriate type of junction

The principal types of junction arrangement available for the designer are:

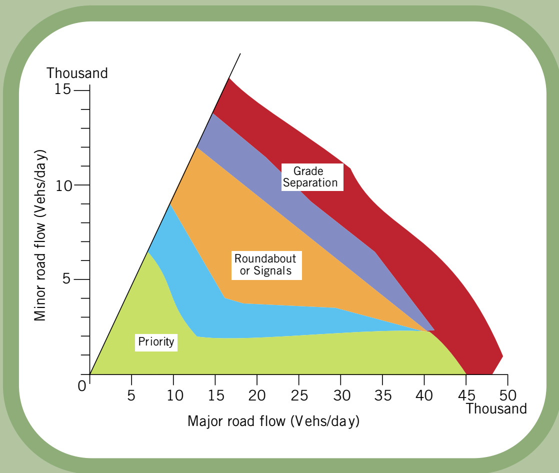
- priority junctions (stop or yield)
- roundabouts
- traffic signal control junctions
- grade separated junctions

Priority junctions have the advantage that they cause little delay for major road traffic. They are the most common form of junction and work best where the traffic flow on minor roads is relatively low in relation to the major road flow. For them to operate safely there needs to be:

- adequate gaps in major road traffic for vehicles to enter and leave minor roads safely
- specific facilities for significant numbers of turning vehicles such as turning lanes and adequate width for the swept path of long vehicles
- low speeds and adequate sight distances
- specific facilities (such as crossings) for cyclists, pedestrians and mobility impaired road users.

Priority junction

Diagram 8.1 Type of junction based on traffic flow levels



Junction choice is determined through assessment of all user needs, not just those of vehicular traffic.

Traffic signals and roundabouts (including mini-roundabouts) should be considered as an alternative to priority junctions when there are substantial delays to minor road traffic or where there are accident problems relating to vehicle turning movements.

The choice between signals or roundabouts for any given location in an urban area depends on a number of factors:

- traffic signals can offer the facilities to give particular types of vehicle (such as buses) and vulnerable road users priority. They generally have a lower land take requirement than normal roundabouts and are often cheaper and easier to implement in urban areas
- roundabouts can present safety problems for pedestrians and cyclists unless the roundabout has been designed for these users (see Cycle manual)
- properly maintained, signalised junctions retain higher capacity than roundabouts, and are safer for vulnerable road users
- Co-ordinated traffic signal systems can be disrupted if roundabouts are located within the control area of the signals
- mini-roundabouts should be regarded as a remedial measure to treat specific problems on existing roads, rather than a general traffic management solution. Alternative junction types are preferred in new developments
- mini-roundabouts can help to reduce speeds and create a better balance of flow at tight urban junctions. They are often used as part of a traffic calming scheme. They should only be used at locations where approach speeds are low. Specific facilities should be provided for pedestrians and cyclists
- roundabouts tend to be better for isolated junctions where there are significant proportions of turning vehicles (particularly right turns), and traffic flows are evenly balanced with few pedestrians or cyclists
- grade separation should only be considered for the higher levels of traffic flow on Primary distributor roads. Crossing facilities for cyclists and pedestrians must be provided for.

Diagram 8.1 gives guidance on the selection of appropriate junction types based on major and minor road traffic flows. This however should only be regarded as a starting point and the final decision should be based on an assessment of all users needs and analysis of the types and volumes of traffic to be catered for together with any site constraints and other factors such as those outlined above.

8.3 General design principles

First and foremost, junctions should be obvious and readable by all road users. Junctions should be kept clear of all advertising signs, in the interests of road safety.

There are a number of design principles that are common to each type of junction to ensure safe and efficient operation.

The type of junction control provided along a route should be consistent with the environment, which the road runs through. It should also be appropriate for the nature and volume of vehicles and pedestrian/cyclists that use the junction.

The geometric layout of a junction should cater adequately for all road users that are likely to use it. Provision should be made within the layout for:

- visibility for drivers at the junction so that they can see other road users in order to carry out their movements safely
- adequate visibility for drivers approaching and leaving the junction
- adequate visibility for and of pedestrians and cyclists
- lighting of a high quality at all junctions in urban areas.
- long vehicles including the swept paths of turning vehicles, where appropriate
- turning vehicles

Traffic signs and road markings

- Traffic signs and road markings are required to warn drivers of the presence of junctions so that they can take extra care. Advance direction signs should be provided on major routes to assist drivers in slowing down to turn and take the correct route. The Traffic Signs Manual[1] gives details of the requirements for signing and road markings at a range of junction types. The signs should be sited so that they are clearly visible as road users approach them and allow road users sufficient time to make their manoeuvres safely.

Safety

- Safety measures should be an integral part of the design process to make a scheme work as safely as practically possible. Advice is given in the following chapters of this section on how this can be achieved. Safety audits should be carried out on proposals for all new junctions and for significant junction improvement works, to ensure that safety is taken into account adequately. More information on this is given in Section A, Chapter 2.

Cyclists and pedestrians

- The needs of cyclists and pedestrians should be considered as a fundamental part of the design process rather than as an afterthought once vehicular traffic has been catered for. Good, direct and convenient facilities should be provided where they have to cross traffic streams. Delay to pedestrians and cyclists should be considered with equal significance as delay to other traffic. Specific facilities for crossing roads should be included at all junctions where there are significant numbers of pedestrians or cyclists. Specific facilities should be included for people with a mobility/sensory impairment.

Capacity

- Adequate capacity should be provided to ensure the junctions can cope with intended traffic volumes. At congested locations extra capacity should not be provided to the detriment of road safety or facilities for vulnerable road users.

Safety measures should be an integral part of the design process to make a scheme work as safely as practically possible.

The needs of cyclists and pedestrians should be considered as a fundamental part of the design process rather than as an afterthought once vehicular traffic has been catered for.

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9

chapter 9 Priority Junctions

9.1 Introduction

Priority junctions are the most common form of junction arrangement. They require one or more minor roads to yield (or stop) for the major road traffic flow. A high proportion of accidents occur at these locations and therefore it is important that they are well designed and secure to ensure the safe interchange of conflicting traffic flows with the minimum of delay to all road users.

While priority junctions can be cost effective in terms of land take and on-going maintenance costs, they may not be as good as other junctions at accommodating access to and from areas which generate large numbers of traffic movements.

TD 42/95[1] Geometric design of major/minor priority junctions together with NRA addendum, provides comprehensive advice on the layout and provision of priority junctions on national routes. Some of this advice is not applicable in urban areas where a higher level of pedestrian and cycling activity occurs, speeds are lower and site constraints are generally more onerous. This chapter concentrates on urban area issues and indicates radii and road widths appropriate to such areas. Further guidance on the design of residential roads is provided in Section A, Chapter 1.8.

The main options available to the designer for new priority junction arrangements are:

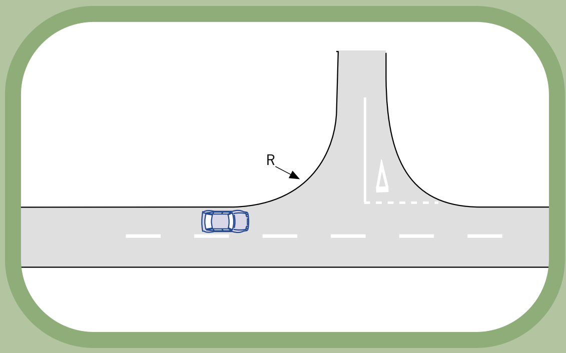
'T' Junctions

A simple 'T' junction layout is shown in Diagram 9.1 and a more complex layout is shown in Diagram 9.3. The most appropriate form of junction depends on the traffic flow volumes on the major and minor roads in the design year.

Staggered junctions

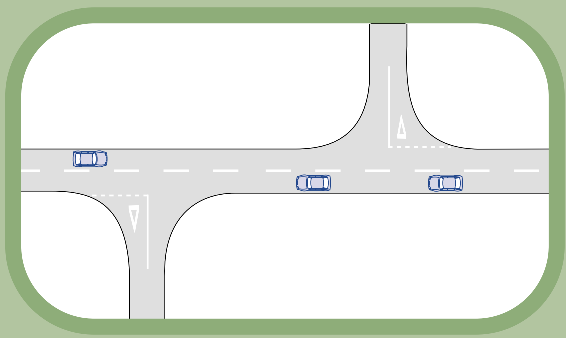
A typical staggered junction layout is shown in Diagram 9.2. Staggered junctions involve offsetting the minor road arms at the junction. This minimises the number of conflicting traffic movements. A right-left stagger is the preferred orientation for the minor roads because it better caters for right turning movements both into and out of the minor roads.
Crossroads layouts are no longer recommended for priority junctions on Primary and District Distributor roads because of the number of conflicting vehicle movements that they create.

Diagram 9.1 'T' Junction



In an urban area, radii are typically 4 to 6m (with a maximum of 10m)

Diagram 9.2 Staggered Junction (right-left)



A crossroads layout can lead to a higher number of accidents than for other layouts. However it can be appropriate in low speed, low volume environments eg residential cells.

9.2 Type of junction and typical layouts

This section gives advice on the most appropriate type of priority junction and illustrates some typical layouts. Whilst standard layouts are useful on new roads it is often difficult to achieve ideal layouts on existing roads in urban areas and compromises may need to be made. TD42/95[1] and NRA addendum gives examples of different layouts. The 'T' and staggered junctions have a number of variations depending on the main road layout.

- Simple layouts without any local widening for turning lanes, see Diagram 9.1
- Ghost island layouts which include provision for right turning vehicles, see Diagram 9.3
- Dual carriageway layouts which include single lane dualing (which is normally used at rural locations only) and dualing with two or more lanes, see Diagram 9.4

The most appropriate type of junction depends on the intended traffic flow volumes on the major and minor roads in the design year and the requirements of vulnerable road users. Diagram 8.1, Chapter 8 gives approximate levels of provision for various major and minor road flows.

In urban areas simple 'T' junctions are the most common arrangement for priority junctions. They often operate at traffic levels well above those recommended in Diagram 8.1.

The provision of ghost island layouts at such locations can bring a number of benefits:

- reduced delays
- reduced accidents associated with right turns and nose-to-tail (shunts) collisions
- opportunities for the provision of islands in the hatched areas to assist pedestrians crossing a road

Disbenefits of traffic islands include

- reduction of the effective road layout width (loss of space for bus or cycle facilities in many cases

Diagram 9.3 Ghost island layout on main road

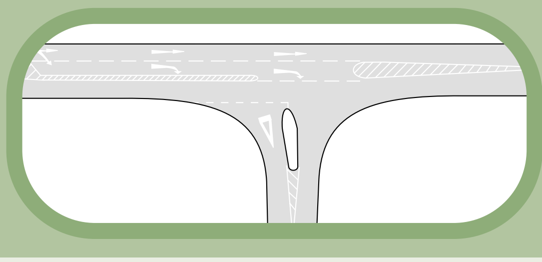
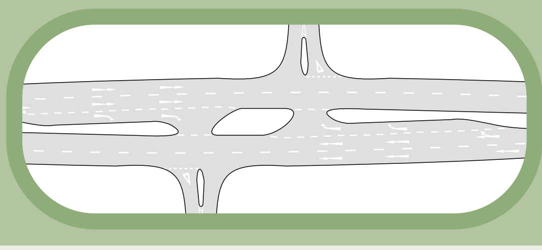


Diagram 9.4 Dual two lane with right/left stagger (for Primary or District Distributor roads only)



- creation of pinch point for cyclists
- potential hazard if isolated and not repeated along a road
- requirement for separate electrical supply for internal lighting

Consideration should be given to upgrading simple junctions to ghost island layouts on Primary and District Distributor roads. However this would not apply to Access roads.

9.3 Design principles

The principles of junction design are contained in TD 42/95 – Geometric Design of Major/Minor Priority Junctions1 and NRA addendum.

Priority junctions should be designed and constructed to ensure that:

- delays for main road traffic are minimised
- minor road traffic does not experience significant delays
- the safety of all road users is considered and a layout that operates as safely as practically possible is achieved
- good provision is made for all road users with particular emphasis on vulnerable road users such as pedestrians, cyclists and people with mobility impairments
- drivers are discouraged from overtaking near the junction
- parking and loading is precluded within the sight triangle of the junction

Siting

Priority junctions should not be sited:

- on or near bends (except on low speed residential roads with little turning traffic). Problems with visibility for vehicles on the minor road can occur at a junction sited on the inside of a bend
- on crests where the layout may be difficult for drivers to judge when approaching the junction on the main road
- when a minor road approaches a junction on a gradient greater than 2%. This can lead to drivers failing to perceive the junction correctly (uphill) or overshooting the yield markings (downhill). In such circumstances a level section, at least 15m in length, should be created at the junction.

Design speed

The design speed for a junction is based on the measured 85 percentile speed of traffic on the major road. For new roads this will have to be estimated and advice on this is given in NRA TD9/002 Road link design and NRA TA 43/002 Guidance on road link design and NRA addendum.

Right turning movements

Right turns are the most difficult movement to cater for at priority junctions because they have to cross opposing traffic streams. Vehicles waiting to turn right can cause significant delays for other traffic at a priority junction. As the majority of accidents at priority junctions on primary or district distributor roads involve right turning movements, therefore right turn movements should be well provided for in the design. On single carriageways the provision of a ghost island layout is the best way to cater for right turns (see Diagram 9.3). On dual carriageways, a break in the central reservation together with a turning lane is required (see Diagram 9.4). The turning lanes require detailed design based on the speed of traffic and gradient on the major road. On Local Collector and Access Roads dedicated right turn facilities are not required.

Merging and diverging lanes

Merging and diverging lanes are only used in an Urban area on Primary Distributor roads. Merging lanes are useful to assist left turning vehicles to join high speed dual carriageways. Vehicles on the major roads can change lane to facilitate access for merging vehicles.

Merging lanes should not be used on single carriageways because major road vehicles cannot change lanes to allow joining vehicles easier access.

Diverging lanes can offer advantages when there are high volumes of vehicles turning left from the major road. They should not be introduced without providing for cyclists and pedestrians in urban areas. On single carriageways turning vehicles in the diverging lane can mask minor road drivers' views of other traffic when they are waiting at the yield markings.

Traffic signs and road markings

In urban areas there are many priority junctions but not all of them require signing (direction or warning). However, key junctions where there are routes to specific destinations or services will require signing. Direction signs should be provided in advance of these junctions to ensure that road users are made aware of the proximity of a junction as they approach it. Advance direction and warning signs in advance of the junction should only be provided at priority junctions in urban areas where there are particular needs. These could include junctions with substantial turning traffic volumes, accident problems involving turning vehicles or inadequate advance visibility of the junction. All signs should be of a sufficient size to be read by drivers and larger signs are required on roads with higher traffic speeds. Warning signs and advance direction signs should be located within a prescribed distance of the junction in relation to the speed of approaching traffic. This will allow drivers to react to the signs and slow down or stop if necessary.

The signs should also be clearly visible to approaching drivers. Care should be taken to ensure that signs are not positioned at locations where they may be obscured by foliage from trees/bushes or by structures. The signs themselves should not obscure visibility for other road users.

'Yield' signs and markings control the majority of priority junctions. Stop signs and markings can be used at priority junctions when visibility from the minor road is restricted.

Detailed advice on the provision of signs and road markings is given in the Traffic Signs Manual.[3]

Lighting

Road lighting is intended to illuminate the road surface brightly and evenly. Vehicles and people are silhouetted against the road surface so that they can be easily distinguished. Junctions should be well lit in urban areas so that drivers can see the layout of the junction and other road users such as pedestrians who may be crossing the road or waiting to cross. The lighting columns should be positioned at the back of footways so that they do not obstruct the passage of pedestrians and to minimise the risk of their being hit by vehicles. High pressure sodium lighting is preferred to low pressure sodium lighting as it provides a better quality of light and illumination for road users.

Lane widths for Primary Distributor roads in Urban areas

Lane widths need to be adequate to cope with the volume and type of vehicles likely to use them. Table 9.1 recommends desirable and minimum widths for lanes on Primary Distributor roads at priority junctions in urban areas. When converting (or improving) existing urban simple junctions to a ghost island layout there may be constraints on the lane widths that can be achieved. The provision of turning lanes even with the minimum width will still produce significant benefits in a number of circumstances, for example where:

- the volume of trucks and buses is low (5% or less)
- speeds are low (85% speeds are less than 30mph)
- there is a need to provide islands for pedestrian crossing movements

The widths in Table 9.1 do not include provision of hard strips and cycle lanes. Widening of the lanes may be required on bends with radii of 100m or less.

Lane widths for district distributor, local collector and access roads in urban areas

Lower vehicle speeds are required on these categories of roads. Lane widths greater than the widths recommended in table 9.2 will increase speeds and will reduce capacity and/or safety, and are therefore undesirable.

Visibility

Good visibility is essential at junctions to ensure that road users can complete their movements safely and so that vehicles can slow down or stop if traffic conditions require.

Visibility from the minor road

As drivers on the minor road approach the yield or stop lines they should have adequate visibility of traffic on the major road to both their left and right. Diagram 9.5 and Table 9.4 summarise the required visibility splays based on the approach speed of traffic on the major road. This visibility should be available from a set distance back along the centre line of the minor road the 'x' distance and forms a visibility splay, with the 'y' distance along the major road.

For urban areas, an 'x' distance of 4.5m or greater should be provided. This may be reduced to 2.4m in exceptional circumstances.

If it is not possible to achieve these distances then an alternative access position should be considered (for new junctions) or measures to reduce the approach speed of the major road traffic should be implemented.

Forward visibility on the major road

Drivers approaching the junction on the major road need to be able to see the junction in order to be aware of traffic entering from the minor road and to be able to slow down and safely stop, if required. The junction and its approaches should be clearly visible from a distance equivalent to the 'y' distance in Table 9.4 for the approach speed of traffic. This is known as the stopping site distance and detailed advice on this is given in NRA TD9/002 and NRA addendum. If it is not possible to achieve the required distance then an alternative access position should be considered (for new junctions) or measures to reduce the approach speeds should be implemented.

Corner kerb radii

It is important that the swept paths of the longest vehicles likely to use the junction can be catered for. This requires the provision of adequate kerb radii on the corners of the junction. Swept paths can be tested on junction layouts using either proprietary computer software or by using templates for different vehicles with a variety of turning radii and angles.

Table 9.1 Typical lane widths for single carriageways (Primary Distributor roads)

TYPE OF LANE	DESIRABLE WIDTH (m)	MINIMUM WIDTH (m)
Through lane	3.65	3
Right turn lane	3.5	2.5
Bus lane	3.5	3.0

Kerb to Kerb width should be a minimum of 7.0m (See cycle manual regarding provision of cycle facilities)

Table 9.2 Typical lane widths for District Distributors and Local Collector roads

TYPE OF LANE	DESIRABLE WIDTH (m)	MINIMUM WIDTH (m)
Through lane	3.0	3.0
Right turn lane (District Distributor only)	2.5	2.5
Bus lane	3.0	2.8 at pinch point
Cycle lane (See cycle manual)	1.8	

Kerb to Kerb width should be a minimum of 6.5m

Table 9.3 Access Roads

Kerb to kerb width (excluding any inset parking) should generally be a maximum of 5m.

In an urban context, side road junction mouths should be as compact as possible - this reduces pedestrian crossing times, assists cyclists, and discourages inappropriate vehicle turning speeds. However, on primary and district distributor roads, these swept paths should generally be catered for without requiring long vehicles to overrun into other traffic lanes. This may require the provision of a taper (local widening at the corner, see Diagram 9.6) which also helps to avoid the rear wheels of long vehicles encroaching onto footways.

On local roads with few long vehicle movements it is acceptable to cater for their swept paths by allowing occasional overrunning of other vehicle lanes providing that there is adequate visibility. Such movements should not cause significant problems if long vehicle movements are infrequent. This allows the kerb radii to be reduced in areas where there are likely to be pedestrian movements. This also helps to reduce vehicle speeds and the distance to walk across the bellmouth of the junction. Care needs to be taken to ensure that the reduction in corner radii does not cause long vehicles to overrun the footway.

As a general guide for urban areas the following kerb radii should be adequate:

- 6m on local roads where there are low numbers of long vehicles turning
- 10m on busier roads. Tapers (30m long developed at 1:5) can be provided where long vehicles are likely to overrun the footway. These are not generally suitable for urban areas because they make pedestrian and cycle movements more difficult. Such tapers are more likely to be provided in industrial areas

At locations where long vehicles form a significant proportion of turning vehicles then larger radii or a compound curve can be considered. In such cases reference should be made to TD42/95[1] and NRA addendum.

Islands can also be installed in the bellmouths of junctions to channelise traffic and assist pedestrians crossing the mouth of wide junctions or accesses. Care needs to be taken that the swept paths for all vehicles likely to use the junction can be accommodated.

Diagram 9.5 Visibility splay requirements from minor road

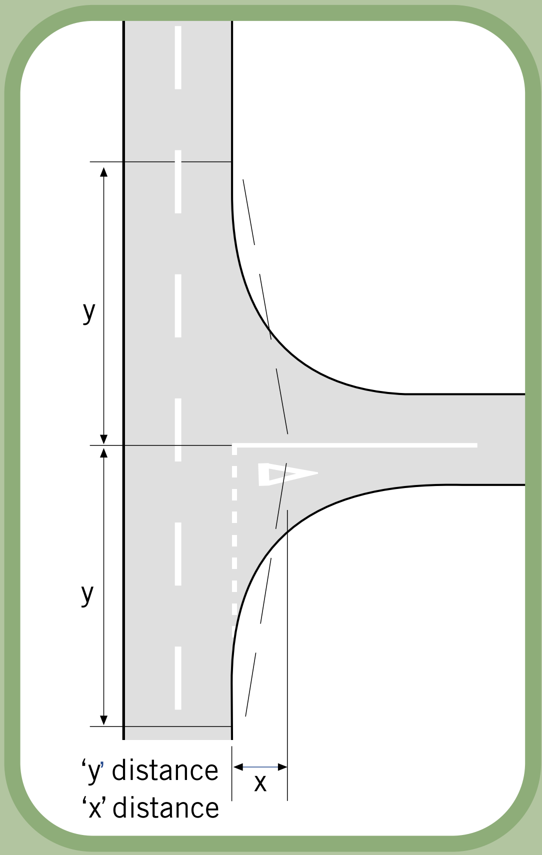


Table 9.4 Visibility distance from minor road

Design speed (or 85% actual speed) of major road (km/h)	'Y' distance (m)
50	70
60	90
70	120
85	160
100	215
120	295

9.4 Capacity analysis and computer models

New or improved priority junctions should be designed with a view to their impact on the overall network. In many cases it may be desirable to limit access from the side road onto the main road (to discourage rat running for instance). On the other hand, it may be desirable to provide some reserve capacity for future traffic growth. However, as conditions change (eg pedestrian needs) an alternative form of junction such as traffic signals may be required in the future.

Capacity calculations are undertaken using computer software packages. The most commonly used computer software available is produced by the Transport Research Laboratory (TRL). PICADY (Priority Junction Capacity and Delay) uses geometric parameters to enable different layouts to be modelled against a range of predicted flows. The model outputs information on queues, delays and capacity (RFC – Ratio of Flow to Capacity) for each arm of the junction. It will also output accident predictions (based on UK experience). If the RFC value for each arm is less than 0.85 in the design year then no significant delays would be expected at a junction.

As with all computer models, care is needed with the interpretation of the results and checks are necessary to ensure that the overall design still produces safe and acceptable operating characteristics.

Unfortunately, the programme does not consider the needs of vulnerable road users in the design process and any outputs of accident rates should be checked against local control data to ensure that they are applicable to local conditions.

Diagram 9.6 Corner with taper

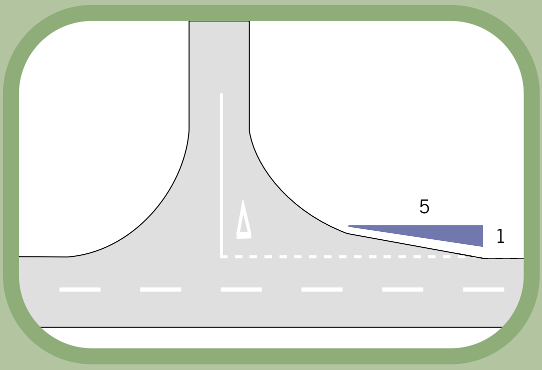
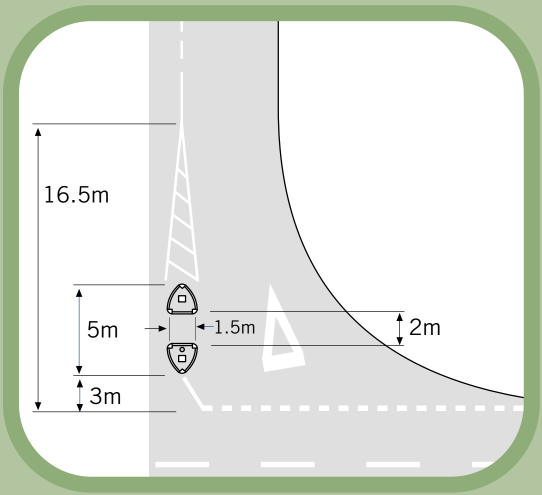


Diagram 9.7 Island in junction bellmouth



9.5 Safety issues

Priority junctions are the most common form of junction control and (perhaps as a result of this) a high proportion of accidents occurs at these locations. It is therefore important that good design and construction practice for both safety and capacity is followed.

The most common accident types at priority junctions are those involving right turns. Provision of the following features can help to improve safety at priority junctions:

- measures to reduce approach speeds to the junction
- high-friction surface on the major road approaches to a junction
- dished crossings and tactile paving (see Section E, Chapter 13)
- adequate visibility splays for traffic. Care needs to be taken that the visibility splays provided are not too much greater than the desirable standards indicated in Chapter 9.3 otherwise drivers may misjudge traffic speeds or the presence of two-wheeled vehicles

For Distributor roads only, the following features should be considered:

- ghost island layouts to shelter right turning traffic
- use of double white lining, ribbed markings or coloured surfacing in conjunction with islands or hatching
- high visibility guardrail and central islands at pedestrian crossing points. These can often be provided in conjunction with ghost island layouts
- replacing problem crossroads junctions with staggered junctions

Road safety audits should be carried out on the designs of all new priority junctions and on existing ones which are being improved significantly.

Cyclists

Cyclists are at risk at priority junctions because many drivers fail to see them. Facilities should be provided to cross cyclists through the junction on the road, where possible. If possible, a cycle lane with a contrasting surface colour together with appropriate cycle logos should be provided. This will help to alert drivers to the presence of cyclists. Detailed advice on the provision of cycling facilities is given in 'Provision of Cycle Facilities – National Manual for Urban Areas'.[4]

Pedestrians

The provision of facilities for pedestrians at priority junctions should be carefully considered. Pedestrians will always desire to cross the mouth of the junction directly from footpath to footpath. With the exception of high speed distributor roads, pedestrians should be accommodated at the junction mouth. On major roads such as District Distributor roads the provision of central refuges or formal crossings can help the more vulnerable pedestrians to cross. Dished crossings should be provided for pushchairs and wheelchairs (see Section E, Chapter 13). Islands can be installed in the bellmouths of wide junctions to help pedestrians to cross (see Diagram 9.7).

9.6 References

1. TD42/95 – Geometric Design of Major Minor Priority Junctions and NRA addendum – NRA addendum available from NRA, St Martin's House, Waterloo Road, Dublin 4, Ireland. Tel 01 660 2511 Fax 01 668 0009.
TD42/95 available from The Stationery Office, Telephone orders +44 870 600 5522, Fax orders +44 870 600 5533

2. NRA TD9/00 Road link design and NRA TA43/00 Guidance on road link design. Available from National Roads Authority, St Martin's House, Waterloo Road, Dublin 4, Ireland.
Tel 01 660 2511 Fax 01 668 0009

3. Traffic Signs Manual – Department of the Environment. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879;
Fax 01 6476843)

4. Provision of cycle facilities – National Manual for Urban Areas – Dublin Transportation Office / Department of the Environment & Local Government.
(Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section,

10

chapter 10 Traffic signals

10.1 Introduction

Traffic signals were first used in London at the end of the 19th century with the first set of signals installed in Ireland in 1938 at the intersection of Clare Street/Merrion Square, in Dublin.

Traffic signals are often the best form of junction control where road space is limited and there is pedestrian crossing movement. It is possible to link traffic signals and co-ordinate their timings along a route or throughout an area to ensure that there are no queues back through important links. It is generally cheaper to introduce traffic signals than to construct a conventional roundabout with the same capacity.

In the past, specific warrants for the use of traffic signals were contained in RT.181 – the NRA's Geometric Design Guidelines[1]. However, current practice is to rely less on absolute figures within warrants and to rely on engineering judgement within an overall transport strategy to decide whether or not traffic signals are the correct form of junction control.

Within an overall transport strategy, traffic signals can be introduced as a positive means of managing and controlling traffic for a wide variety of reasons:

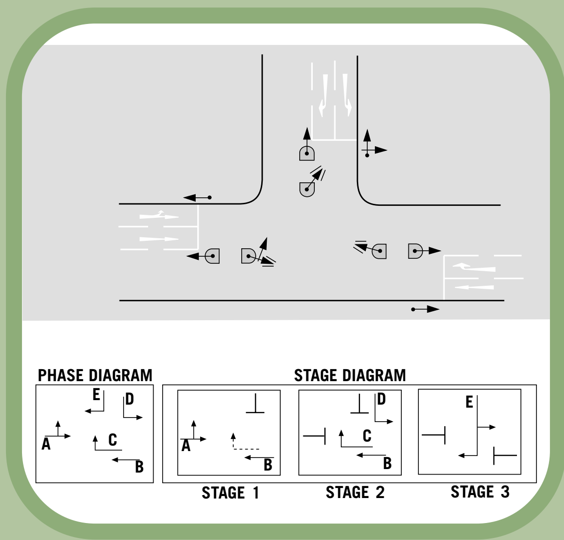
- managing congestion
- improving safety
- providing facilities for pedestrians and cyclists
- providing priority for public transport including light rapid transport (LRT)
- providing priority for emergency service vehicles
- limiting traffic flow by demand management
- improving air quality
- reducing speeds

Traffic signals can also have disadvantages:

- they can increase off peak delays for all road users
- they are not always good at dealing with right turning movements
- they are not suitable for high speed roads (85% speeds of 65mph and above)

Traffic signal junction

Diagram 10.1 Phase and stages



This chapter gives general information and advice on the use of traffic signals, which can be used to improve existing signal junctions and help to design new signal junctions. A full traffic signal design guide is beyond the scope of this manual. Chapter 9 of the Traffic Signs Manual[2] and TD50/99[3] and NRA amendment give advice on the use of traffic signals and a number of references for more detailed information on geometric layout, signalling strategies etc. are given in 10.14.

10.2 Definitions and terminology

Some of the most common terms used by traffic signal engineers are outlined below.

Cycle Time

The cycle time is the time taken for one complete sequence of the traffic signals. For example, from the start of green for one approach to the next time the green starts for the same approach is known as the cycle time. Cycle times are generally between 40 seconds and 120 seconds. Cycle times in excess of 120 seconds are not recommended as drivers and pedestrians can get frustrated with delays and can be tempted to take risks. **Shorter cycle times (90 seconds or less) should be provided in urban areas in order to minimise delays to pedestrians, cyclists and vehicles.** However, cycle times in excess of 120 seconds are acceptable in the context of restricting side road access onto a main road so long as drivers are informed by signage.

Phase

The signal sequence for one or more streams of traffic (or pedestrians) that receives an identical signal display (see Diagram 10.1). They are the various separately signalised movements in a junction.

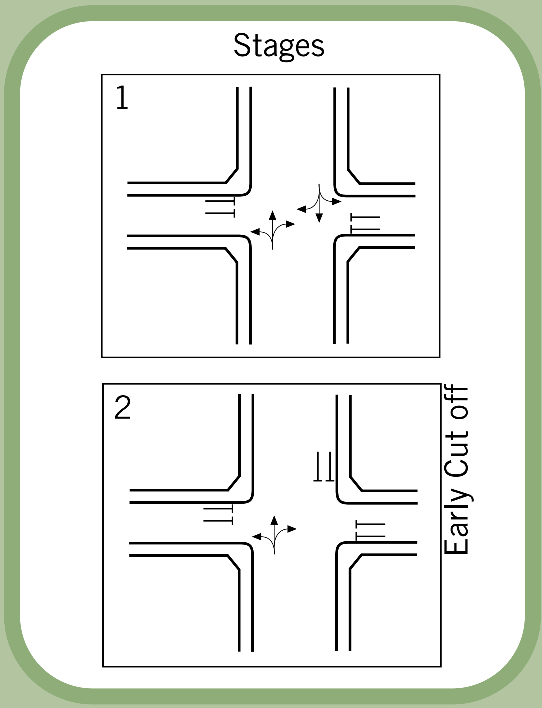
Stage

A period when a particular combination of phases are displayed (see Diagram 10.1).

Phase and stage intergreen

The time between the end of the green for one phase or stage and the start of green for the next phase or stage. The length of the intergreen period varies (see Chapter 10.3).

Diagram 10.2 Early cut-off



Shorter cycle times (90 seconds or less) should be provided in urban areas in order to minimise delays to pedestrians, cyclists and vehicles.

Early Cut-Off

A sequence where one phase is terminated to facilitate another conflicting phase, whilst allowing other associated phases to continue. A common use is where a phase is terminated early to allow an opposing right-turn phase (see Diagram 10.2). These are useful to clear right turn queues at locations where separately signalled right-turn stages cannot be justified or would increase peak hour delays too much. A closely associated secondary signal should be used in this arrangement (see 'secondary traffic signals').

Late Start

A sequence where a phase is released later than other phases. This can be used to hold traffic on an opposing approach whilst a conflicting right turn is allowed to take place (see Diagram 10.3). This is generally used when there is insufficient stacking space for right-turning vehicles on an approach. A few right-turning vehicles would effectively block other vehicle movements so they are allowed to go first to clear any potential blockages. Care is needed with the use of a late start as it can confuse the drivers whose phase is held and released late. It can cause conflict with pedestrians who may not be expecting these traffic streams to start at different times.

Primary traffic signals

There must be at least one primary signal at each stop line. The primary signal is normally sited on the nearside (footpath side), between 1m and 5m beyond the stop line. Additional primary signals should be sited on the offside in one-way streets or on dual carriageways and at locations with a splitter/pedestrian crossing island in the centre of the road. On faster roads or roads with 4 or more approach lanes, high mounted or overhead additional signals should be considered. Similarly if visibility of the signal heads is restricted by a crest in the alignment, then high mounted or overhead additional signals (6m) should be considered.

Signals should be visible within the stopping sight distance of the junction. Neither parking/loading nor street furniture should block the approach view of the signals, (e.g. within 50m of the signals).

Diagram 10.3 Late start

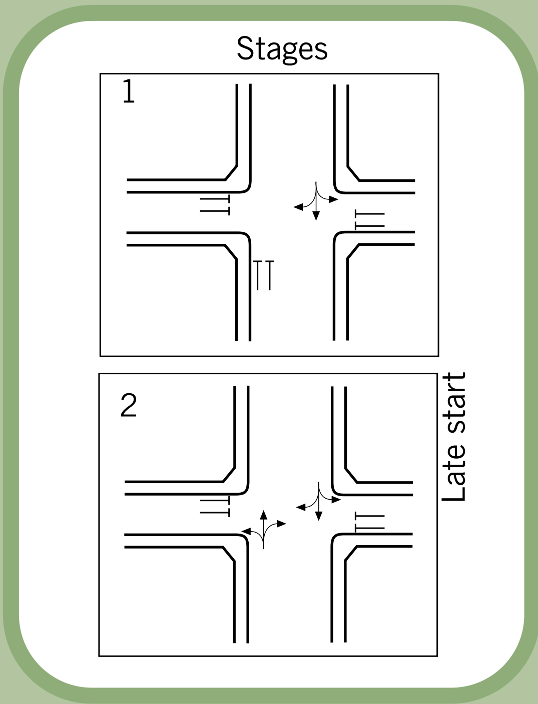
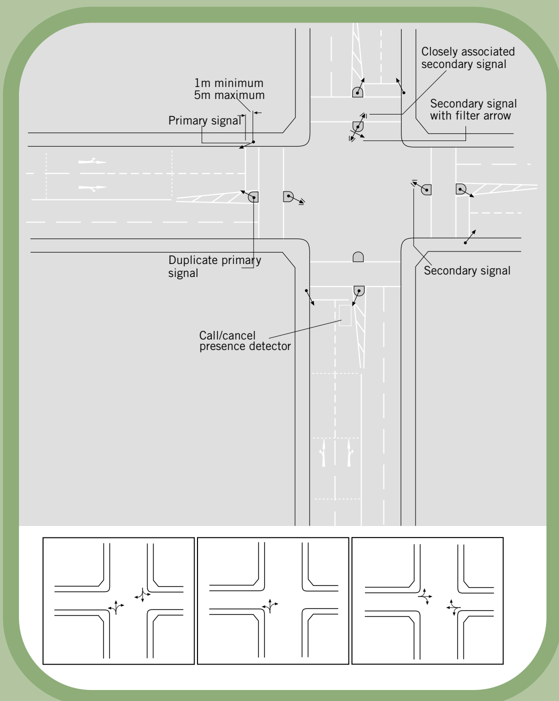


Diagram 10.4 Primary and Secondary traffic signals



Secondary traffic signals

Generally there should be at least one secondary signal associated with every stop line, except for bus gates where it may not be feasible to install one. The secondary signals are normally sited on the opposite side of the junction where they can be seen easily by drivers waiting at the stop line.

Where a vehicle is waiting to turn right at a junction and there is an opposing right turn movement with an early cut-off facility, drivers could be confused when the secondary signal for their movement turns to red. The driver would normally expect oncoming traffic to stop and would use the intergreen period to complete their turn. However, when an early cut-off phase operates then the opposing traffic continues to run. This has resulted in accidents at some junctions. This confusion can be avoided by locating the secondary signals on the same side of the junction as the stop line (but beyond the primary) so that drivers who have crossed the stop line and are waiting to turn right cannot see it. These are termed closely-associated secondary signals (see Diagram 10.4).

Eye-height signals

In certain circumstances, eye-height signals can be effective, especially where the primary or secondary signals are not visible. These eye-height signals must be used in addition to (not replacing) primary and secondary signals.

10.3 Principles of traffic signal control

At a junction there are demands for movements which conflict with each other, for example turning traffic, minor road traffic, pedestrians etc. Traffic signals are designed to minimise the various conflicting manoeuvres at a junction by allocating time and road space to vehicle and pedestrian movements in a sequence. They should provide good facilities for all road users including cyclists, pedestrians and mobility-impaired users (see Section E).

Traffic signal design aims to give adequate time to each traffic stream and road user while keeping the overall cycle time as short as possible. There are various methods of control for stand alone traffic signal junctions:

- Vehicle actuated – the timings of each phase/stage are varied between the pre-set minimum and maximum times, according to the demands indicated by the vehicle and pedestrian detection systems. It is possible to miss out or cut short certain phases/stages of the cycle if no demands are registered for these. Vehicle actuation offers significant benefits at stand-alone signal junctions. It adjusts the signal timings to suit the traffic flows at the time and if properly set up and maintained keeps overall vehicle delays to a minimum. All stand-alone signals should operate with vehicle actuation as their normal mode of operation.

- Fixed time – the timings of each phase/stage and the overall cycle time are predetermined and activated by a time clock within the controller. A number of different time plans (for example am peak, pm peak, off-peak and overnight) can be programmed. No vehicle detection systems are required for this type of operation but demand dependant stages (for example pedestrian stages) can be incorporated into these. The main disadvantages of this method of operation are the longer delays to vehicles off-peak (most of the day) and that the plans can quickly become out of date as traffic flows change. Fixed time control should only be used where the signal installation is part of a network of linked signals or as a back-up when there is a fault with the vehicle actuation at stand alone signals
- Manual control – The timings can be operated manually in special circumstances such as special events, usually by An Garda Siochana.

Traffic signals can also be controlled in a manner which co-ordinates their operation with adjacent signals (see Chapter 10.11).

Traffic signal equipment

Each signal installation includes (see Diagram 10.5):

- A controller – a microprocessor and other control equipment e.g. detector pack, power supply etc. normally contained within a 'large grey cabinet'. The equipment controls the operation of the signals. In particular the phasing and staging of the junction and the time allocated to each are programmed and stored within the controller's memory
- Signal poles and heads – a number of primary, secondary and where necessary pedestrian and cycle signal heads, together with poles
- Detection equipment – vehicle, cycle and pedestrian detection equipment of various types (see section on detection systems)
- Other street furniture such as traffic signs etc.
- Road markings – including stop lines, lane markings and arrows

Each of the primary, secondary and pedestrian signals together with the detection systems are connected to the controller by cables. These allow the controller to receive information from the detection systems and change the signal displays accordingly. The cables are generally run through ducting which runs underneath the carriageway and footway. Older installations may have cables buried directly in the carriageway. Care will be needed when deciding the routes of ducting to ensure that there is no conflict with any other utilities or cables.

The controller is pre-programmed with information about the permitted phase and stage combinations that can operate at the junction. The minimum and maximum phase and stage times together with the intergreen times are pre-programmed.

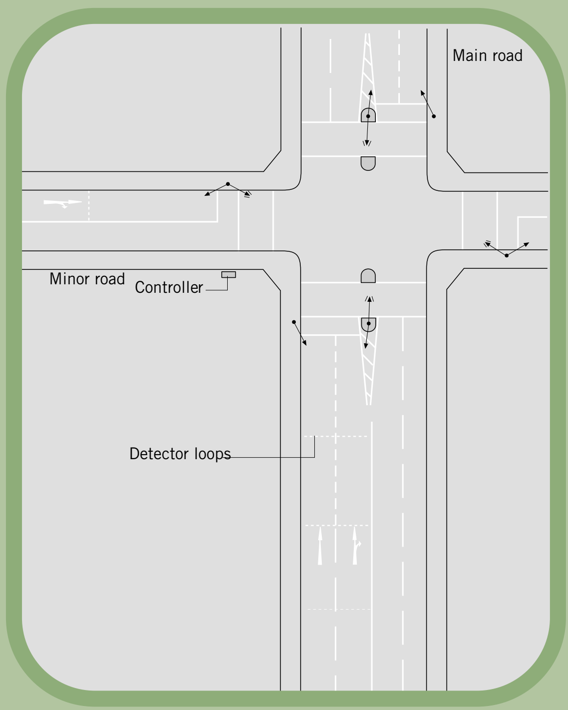
Sequence of signal displays

In Ireland, in common with many other countries, the signals change directly from red to green. In the UK, there is a two second period when red and amber show together before the green signal shows. This additional period is thought to reduce the lost time between stages and improve safety but there does not seem to be any definitive research in the area.

Determining minimum and maximum phase/stage times

At stand-alone sets of traffic signals the timings should be determined in a real-time method by detecting traffic approaching the junction (vehicle actuation). The minimum stage

Diagram 10.5 Traffic signal equipment



time is usually set at around 7 seconds (4 seconds for filter arrows) and is extended in units of around 1.5 seconds up to the pre-set maximum time. The maximum setting is pre-determined and programmed into the controller. When installing new traffic signals or updating timings, computer models (Chapter 10.5) can be used to assist in determining the most efficient settings. The timings can be fine-tuned after observing traffic conditions on site. Signal controllers can store a number of different maximum greens so that the timings can be set to suit traffic flows at different times of a day.

Determining intergreen times

Intergreen times allow streams of traffic or pedestrians in a phase to clear the junction before a conflicting phase commences. The layout of the junction is examined to determine how long is required between each phase or stage change (the intergreen). The intergreen times can vary between 5 seconds for compact junctions and 10 seconds or more for junctions with a long distance between entries and exits. Particular care is needed when pedestrian phase follows a traffic phase. In this case the intergreen time should allow vehicles (including right-turning vehicles that will use the intergreen to complete their turn) to clear the crossing point before the pedestrian phase starts. A method for estimating the required intergreen times is given in TA16/81[4]. The timings can be fine-tuned after observing traffic conditions on site.

Detection systems

Detection systems are used to call or extend phases in the signal sequence. The main forms of detection in use are:

Inductive loop detectors are loops buried in slots cut into the road surface and connected to the controller. They work by detecting the passage or presence of vehicles over the loop. A number of different layouts can be used depending on the function of the loop. The three main types are:

- A 3 loop system (X, Y, Z loops referred to as ‘System D’) to call/extend a particular phase. The loops are situated 39m, 25 m and 12m respectively from the stop line on the approach.
- Presence detectors that call or cancel demand for a specific phase (for example a filter arrow for a queue of right turning vehicles). These should be positioned where the vehicle in the queue that would require the phase to be called is located.

Diagram 10.6 Signal Timings

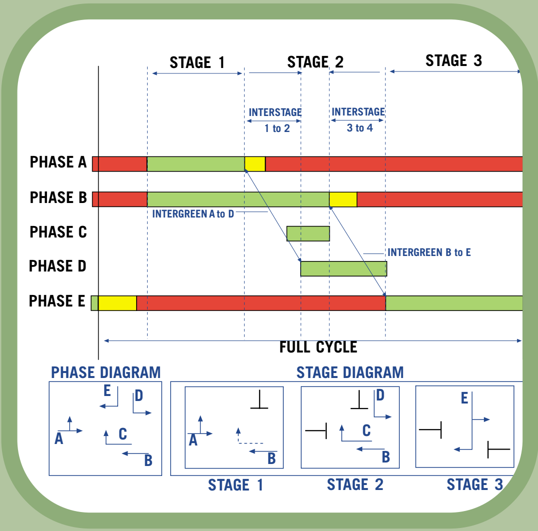
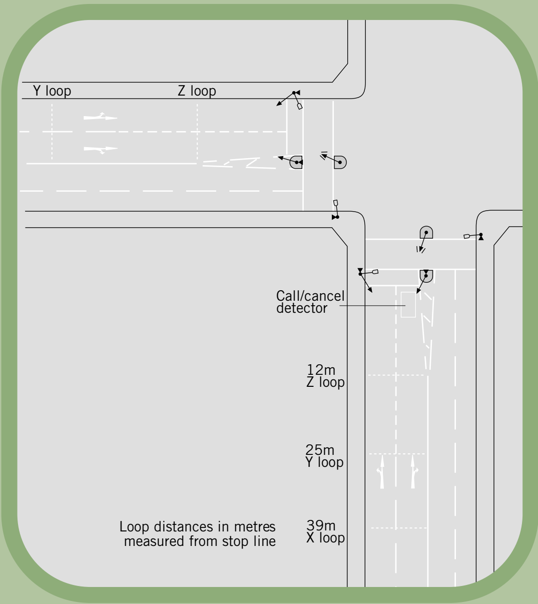


Diagram 10.7 Loop detection



- Speed discrimination/assessment loops for roads with 85% approach speeds over 45mph.

One disadvantage with loops is the cost of maintaining them and the frequency with which they can be severed by other organisations working on the road.

Other loop detection systems are used in association with adaptive UTC systems such as SCOOT and SCATS (see Chapter 10.11). Another system called MOVA[5] has been developed and used in the UK, for semi intelligent and isolated junctions.

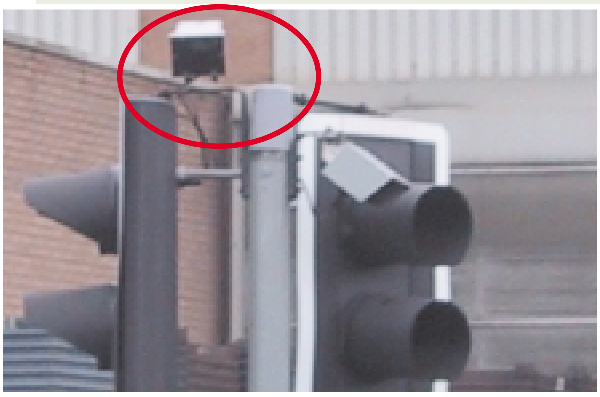
Rear Queue detection loops are positioned on important links to alert that the queue back from a junction has exceeded the desired maximum queue length.

Microwave vehicle detectors (MVDs) detect movement and are used in two main ways. The most common use is to detect traffic on the approaches (vehicle actuation). They cover the length of the approach within 40m of the stop line, performing the same function as the X, Y, Z loops. The other use of MVD's is at signalled pedestrian crossing points to detect pedestrians on the crossing. They are used to extend the crossing time for slow moving or large groups of pedestrians. It is imperative that such detectors are regularly checked for proper beam direction.

Infra red detectors (IRDs) detect presence rather than movement and are used in two main ways. The first is as kerb side detectors to detect the presence of pedestrians waiting to cross. The IRD is often used a supplement to a push button unit. If the pedestrian crosses before the pedestrian phase arrives then it will cancel the demand so that drivers are not delayed unnecessarily. The second use is as an additional detector at a stop line to ensure that slow moving vehicles such as cycles are detected and the required phase is called.

Push buttons

Push buttons are used to call pedestrian phases and can incorporate tactile indicators for blind or partially sighted people. Audible bleepers should be used where possible but only when there is a full pedestrian stage and all traffic is stopped. This avoids confusion for blind or partially sighted pedestrians who might hear a bleeper relating to a partial pedestrian stage elsewhere in the junction and step out into traffic.



MVD

IRD

Pedestrian Push Button unit

Push button units should be located close to the point where pedestrians will cross (ideally 0.5m from the kerb and 0.5m from the edge of the crossing guidance lines). Push button units should be mounted at a height of 1m to the bottom of the push button unit.

Two types of push-button unit are now commonly used in new installations in Ireland:

The first is a unit where the entire electronic front panel area acts as a push-button. A direction indicator on top of the unit should point in the direction of travel for the pedestrian. A vibrator is located under the direction indicator and allows blind or partially sighted pedestrians to know when to cross.

The second type has a large push-button, a small flashing light and audible indicator. The audible indicator "ticks" slowly whilst a red pedestrian aspect shows. It then ticks more quickly and vibrates when a green pedestrian aspect shows.

An earlier type of push-button unit was subject to vandalism in some areas but some of that type are still in use.

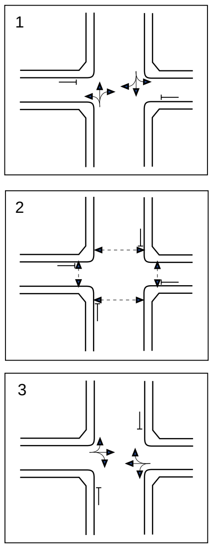
Additional push-button units should be provided on any central islands in the signal layout. This is to cater for slower moving pedestrians who may be unable to cross the full road width in the time allocated.

10.4 Traffic signal layouts and design issues

This section describes some typical traffic signal layouts and associated design issues. Whilst standard layouts are useful on new roads, it is often difficult in urban areas to achieve ideal layouts and compromises may need to be made. Chapter 9 of the Traffic Signs Manual2 gives examples of many different layouts. Advice on the geometric design of traffic signal junctions is given in TD50/993 and NRA addendum.

Pedestrian Push Button

Diagram 10.8 Typical 3 Stage Control



Signalled cross-roads – 3 Stage

A simple form of traffic signal control is at a cross-roads junction as shown in Diagram 10.8. This layout includes a pedestrian stage and relies on drivers using gaps in traffic and the intergreen period to complete right-turning movements. All red pedestrian stages are generally associated with compact junctions (eg islands)

Signalled cross-roads – 4 Stage with early cut-off facility

If one of the right-turn movements is high (say more than 100 vehicles per hour) then an additional stage may be required as shown in Diagram 10.9. This will help to clear the queue of right- turning vehicles and reduce the potential for accidents associated with this movement. This staging arrangement is known as an "early cut-off". In this layout, a right-turn filter arrow is provided on the secondary traffic signal head to indicate to drivers that they will be unopposed during the "early cut-off" stage.

Providing for right-turning vehicles

Right-turning vehicles are often the most difficult stream of traffic to deal with at a traffic signal junction. Their movement is often in conflict with opposing straight-ahead traffic and left turns. Opposing right-turning vehicles can often make the turn more difficult. At most signal junctions vehicles have to use gaps in opposing traffic or the intergreen period to complete their manoeuvre. At busy times there may not be gaps in opposing traffic and therefore only 1 or 2 vehicles will be able to turn per cycle (using the intergreen period). Long queues of turning vehicles can form which can block the junction for other traffic.

There are a number of specific facilities which cater for higher numbers of right turning vehicle including early cut-off and late release (see Chapter 10.3). For higher volumes of right-turn vehicles and junctions with approach speeds over 45mph, separately signalled right-turn stages should be provided.

The proposed signal staging options for catering for right-turn vehicles should be modelled to see which produces the most efficient layout for the traffic flows at the site (see Chapter 10.5).

Diagram 10.9 Typical 4 Stage Control

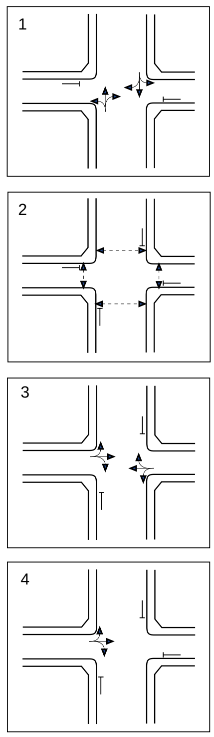


Diagram 10.10 Separately signalled right turns

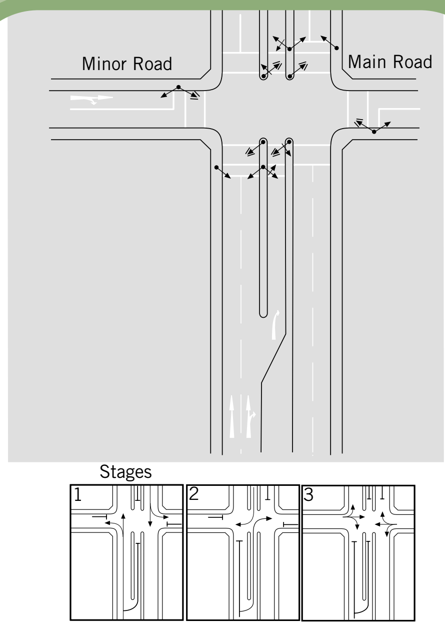


Diagram 10.10 shows an example of a separately signalled right-turn stage.

Lane widths

Lanes on the approaches to traffic signals in an urban area should generally be 3m wide (see Diagram 10.11). This can be reduced to 2.4m in special circumstances.[2] At simple junctions, local widening of the road can help to provide a length of right turning lane. The length should be equivalent to the expected peak hour queue lengths (this depends on signal timings) to avoid blocking of other movements. If this cannot be achieved a shorter length or narrower width may still be beneficial.

Turning circles and swept paths

The turning circles and swept paths of all vehicles likely to use the junction should be catered for where possible. Where no special provision is made for large goods vehicles, minimum corner radii of 6m in urban areas and 10m in rural areas are recommended. Where large goods vehicles are to be accommodated, minimum corner radii of 10m in urban areas and 15m in rural areas are recommended. The proposed layout should be checked using templates of swept paths (or computer simulations) for a range of long vehicles. If their swept paths cannot be accommodated without crossing other lanes or overrunning the footway, it may be necessary to set back the stop lines and provide tapers at the junction.

High-friction surface

If speeds cannot be reduced through the use of narrow lanes and other measures, then high-friction surfaces should be considered for the approaches to traffic signal junctions. This minimises the risk of accidents involving skidding on a wet road surface. Accident studies in the UK have shown that the use of high-friction surfacing at traffic signals can reduce accidents by up to 68%. Where used, high-friction surfaces should be provided for a distance of at least 50m (on 30mph roads) back from the crossing walkway edge line (beyond the stop line). On faster roads greater lengths of high-friction surfaces should be provided.

Visibility

Vehicles approaching the signals require good visibility of the signal heads. The minimum visibility distance required for different approach speeds is set out in Table 10.2.

TABLE 10.1 SELECTING APPROPRIATE RIGHT-TURN FACILITIES AT SIGNAL JUNCTIONS

PEDESTRIAN FACILITY	COMMENTS
Early cut-off	These work best when the one right turn movement at a junction is dominant and opposing right-turns can be cleared within the intergreen period. The volume of right-turning vehicles that would benefit from this facility varies from junction to junction depending on the layout. It is best to model the traffic flows using one of the computer models described in Chapter 10.5. Generally around 2 right-turning vehicles per cycle can clear a junction during the intergreen period. It is worth considering this type of facility if there are significantly more vehices than this.
Separately signalled right-turn stages	These should be considered when there are significant numbers of right-turning vehicles on opposing arms or 85%ile approach speeds exceed 45mph. It is best to model the traffic flows using one of the computer models described in Chapter 10.5.

Symbols

A number of different signal symbols are used on plans to indicate the type of signal heads/aspects and detection systems used in a layout. Some of the more common ones are shown in Diagram 10.12.

Cowls

Cowls are used on signal heads to reduce the effect of bright sunlight, which can make the signal aspects difficult for drivers to see. New light emitting diode (LED) signal heads are much brighter and can overcome problems with sunlight. Cowls also prevent drivers from other approaches seeing the wrong signal. Longer cowls are generally used on secondary signals as their location makes it easier for drivers on other approaches to see them.

Cowls with louvres are also available for use in locations where normal cowls would not be sufficient. Examples of where these are used include:

- where signal heads that can show different lights for different movements have to be located next to each other. Drivers could be confused about which one applies to them
- where pedestrian facilities have been displaced from the junction and drivers could see through to the green light at the displaced facility rather than the red light that applies to them
- where pedestrians using a staggered crossing facility might see a green pedestrian aspect not applicable to them.

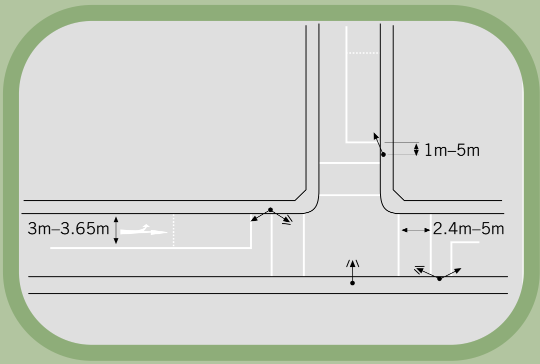
Dimmers

Signal intensity should automatically diminish at night time to prevent glare, In the absence of dimmers, it can be difficult to discern filters in particular

10.5 Capacity issues and computer models

An efficient signalling regime will maximise the safe movement of persons through a junction. Green times should be sufficient to clear queues and the "lost time" (that part of the intergreen period where traffic is stopping or starting) between stages should be kept to a minimum having due regard to safety (see

Diagram 10.11 Lane Widths



High-Friction surface

Table 10.2 Minimum visibility distances

85% APPROACH SPEED km/h	MINIMUM VISIBILITY DISTANCE
40	40m
50	70m
60	90m
80	145m
100	215m
120	295m

Chapter 10.4). Delays to pedestrians and cyclists should be considered in addition to motor vehicle delays. The capacity of a set of traffic signals is determined for the junction as a whole rather than for individual approaches as with roundabouts. Capacity is generally increased by providing more entry and exit lanes. However the wider an approach or exit is the more time that will be required for pedestrians to cross it safely. Strategies for providing pedestrian phases are dealt with in Chapter 10.7.

Signal junctions are generally modelled using a computer program. These computer models are able to handle more complicated junctions and evaluate options more easily.

Computer models

There are two commonly used computer programmes for analysing vehicle movements at "stand alone" traffic signals.

OSCADY is a program developed at the Transport Research Laboratory (TRL) in the UK. It can be used to analyse traffic signal junctions with up to five arms and can be used to predict accidents on four-armed single carriageway junctions (UK based experience only). The program can be set to optimise cycle times and green times and calculates queues and delays for a given traffic flow.

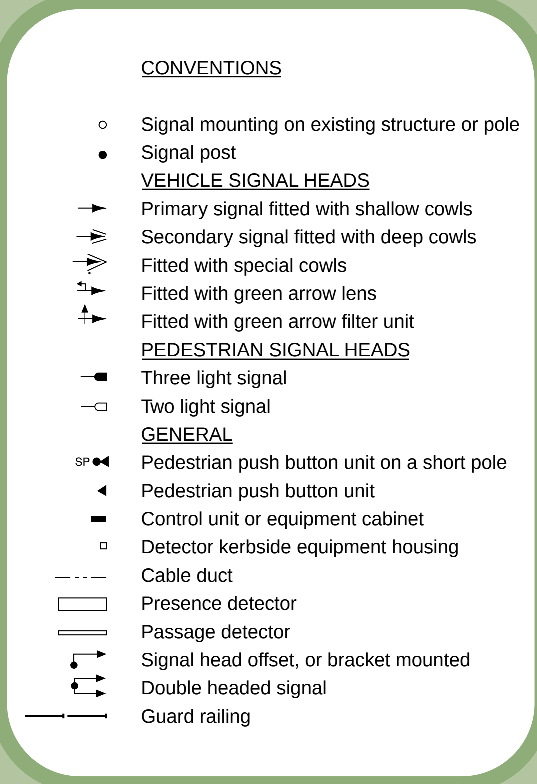
LINSIG is a program that was developed at Lincolnshire County Council in England. Like OSCADY, the program can optimise cycle times and green times and calculates queues and delays for a given traffic flow.

The programs require the following inputs:

- traffic flows including turning proportions together with proportions of trucks, buses, cycles and motorcycles
- junction geometry including entry lane widths, numbers of lanes, flare length and gradient
- permitted turning movements
- phasing and staging details
- mode of operation – VA, fixed time

TRANSYT is another program that models signal operation but is used for networks of linked signals. Linked signals are dealt with in Chapter 10.11.

Diagram 10.12 Signal equipment symbols



Countdown Display

10.6 Safety issues

Traffic signals can offer a safe means of junction control. Some of the more common safety issues that need to be considered when designing traffic signals are:

- Has the design been safety audited?

  All traffic signal designs should be subject to a series of road safety audits during the design and construction process (see Section A, Chapter 2).

- Have conflicting traffic movements (particularly right-turns) been adequately catered for?

  Accidents involving right-turn movements are common at signal junctions. The provision of adequate intergreen times and facilities such as early cut-offs and separate right-turn stages can help to reduce these (see Chapter 10.4).

- Have pedestrians and cyclists been adequately catered for?

  Pedestrian facilities should provided at urban traffic signal junctions (see Chapter 10.7). Consideration should also be given to the provision of advanced cycle stop lines and feeder lanes (see Chapter 10.8).

- Has the risk of red light infringements been minimised?

  The provision of red light cameras can help to discourage infringements. However their use has resource implications for An Garda Siochana and therefore needs their support. Before resorting to the use of cameras, the visibility of signal heads, intergreen times and vehicle detection should be checked for adequacy in relation to the approach speeds of vehicles.

- Do drivers and pedestrians have good visibility of their signals?

  Drivers approaching the signals should be able to see the primary signal heads from a distance in which they can comfortably stop their vehicle if required. Visibility distances for various approach speeds are outlined in Chapter 10.4. Signal heads should be positioned so that trees, planting and signs do not obscure them. If pedestrians are using a staggered crossing in a central island they may be able to see pedestrian aspects that do not apply to them (see Chapter 10.4 'Cowls'). This can lead to pedestrians crossing at the wrong time into the path of vehicles.

- Has high-friction surface been provided on the approaches to the signals?

  When a road surface is wet vehicles need a longer distance to stop. The risk of skidding increases when the road surface is wet and this can result in collisions with other vehicles or pedestrians. These types of accidents are common at traffic signals. Studies in the UK have shown that high-friction surfacing can reduce accidents by up to 60%.

- Has guardrail been provided on Primary Distributor roads to guide pedestrians to the designated crossing point?

  Pedestrians can be guided to the safest place to cross at traffic signals, where appropriate. High visibility guardrail should be used (see 10.7)

- Are the intergreen times sufficient for vehicles to clear both the junction and any pedestrian crossing points?

  Adequate time for vehicles to clear the junction must be provided in order to avoid collisions with other vehicles or pedestrians. These should always be checked on site to ensure that they are adequate.

- Does the position of signal poles and clearance of signal heads (including pedestrian aspects) cause any problems?

  Signal aspects should be mounted a minimum of 2.4m high (to the bottom of the lower lamp) so that they can easily be seen by drivers and do not *present a hazard to pedestrians. Signal poles should be located so that signal heads (including side mounted ones) have a minimum clearance of 450mm from the edge of carriageway. This minimises the risk of them being struck by the wing mirror of trucks or buses. In some locations it is difficult to achieve this clearance without the pole obstructing the footway. Cranked poles (where the top of the pole is cranked inwards to get clearance) can help with this problem (see Section E).*

- Are the traffic lanes well marked and easy to understand?

  On Distributor roads, it is important that drivers can get into the correct lanes as early as possible to avoid turbulence and any conflicts with other drivers. This is particularly important when there are 3 or more lanes on an approach and it may be necessary to supplement the road markings with lane use signs at such locations.

- Has the controller been located correctly?

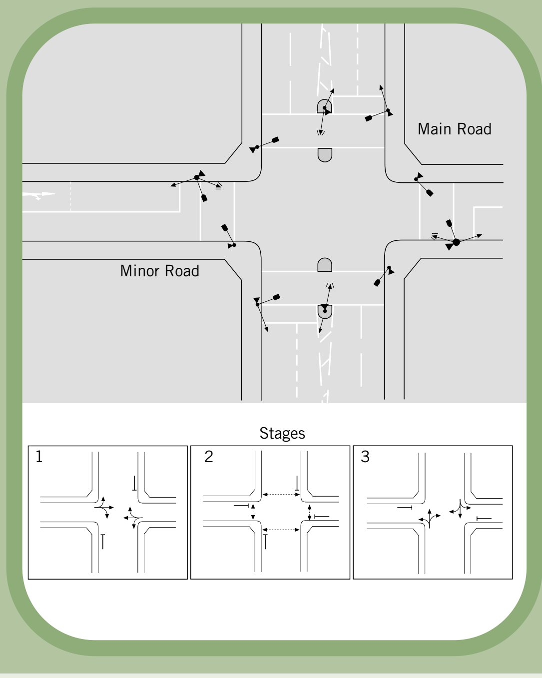
  The controller should be located where a maintenance engineer can get easy access and can see each approach. This position should not obstruct pedestrians using the footway or visibility of pedestrians crossing or about to cross the road. It should be located at the back of the footway (away from the kerb edge) where it is less likely to be damaged by passing or errant vehicles.

- Have the pedestrian detection, dished crossings and tactile indicators been provided and located correctly?

  If a pedestrian phase is provided then consideration should be given to placing push button units at all four corners of each crossing point. The units should incorporate tactile indicators. Dished crossings and tactile paving should be provided at signalled crossing points (see Chapter 10.4).

Missed opportunity to provide pedestrian signals on all junction arms during all red phase

Diagram 10.13 Full pedestrian stage



10.7 Providing for pedestrians

There are a number of ways in which pedestrians can be catered for within a traffic signal junction. Pedestrian facilities should always be provided. They are particularly useful for the more vulnerable pedestrians such as children and people with a mobility/sensory impairment. Sometimes it can be difficult to provide adequate signalled facilities for pedestrians without having adverse effects on peak hour traffic queues and delays but this does not justify the exclusion of pedestrian facilities.

Crossing width

A minimum crossing of 2.4m width in front of the stop line should be provided with an additional 0.5m for every 125 pedestrians per hour above 600 (averaged over the main 4 hours of pedestrian use) up to a recommended maximum width of 5m.

Delays to pedestrians

Delays to pedestrians should be minimised and should be accounted for in the selection of the most appropriate type of pedestrian facility and design. Pedestrians are sensitive to the time they have to wait at the kerbside and if this waiting time is too long pedestrians will cross the road without waiting for a green signal. To minimise pedestrian delays it is important that overall cycle times are kept as short as possible. In some instances it is possible to include the pedestrian phase twice during one cycle of the signals (double cycling). In the climate of encouraging walking as part of sustainable transport, justification for pedestrian facilities should be considered more in terms of the needs of pedestrians[7] (in particular the delays and difficulties experienced in crossing a road) than in always maximising traffic flows. Guidance on the justification for a pedestrian stage at a set of traffic signals is given in TA 15/81[6] and for pedestrian crossings in Local Transport Note 1/95[7]. The 1970 Foras Forbartha system of warrants contained in "Warrants for the installation of Pedestrian Crossing Facilities" is now over 30 years old and is superseded by the recommendations in this document.

Guardrail (for Primary Distributor Roads only)

On Primary Distributor roads, guardrails can help to guide pedestrians to cross at the correct place. High visibility guardrail should be used at these locations because the vertical bars of

Diagram 10.14 Walk with traffic

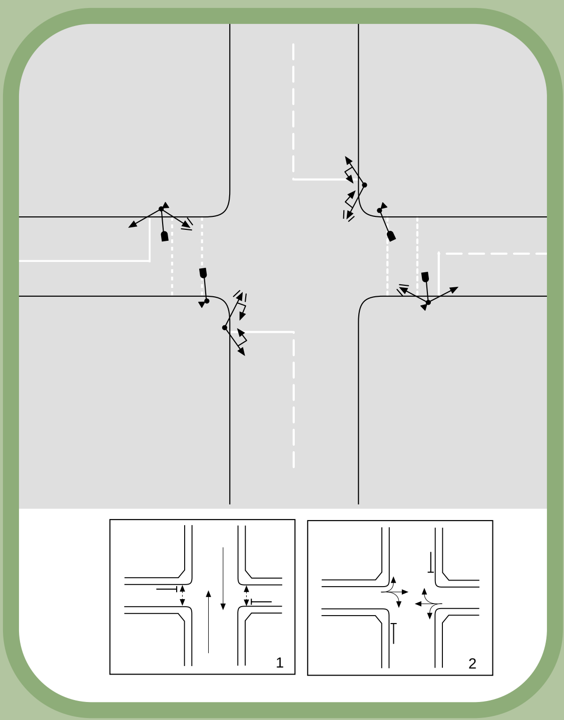
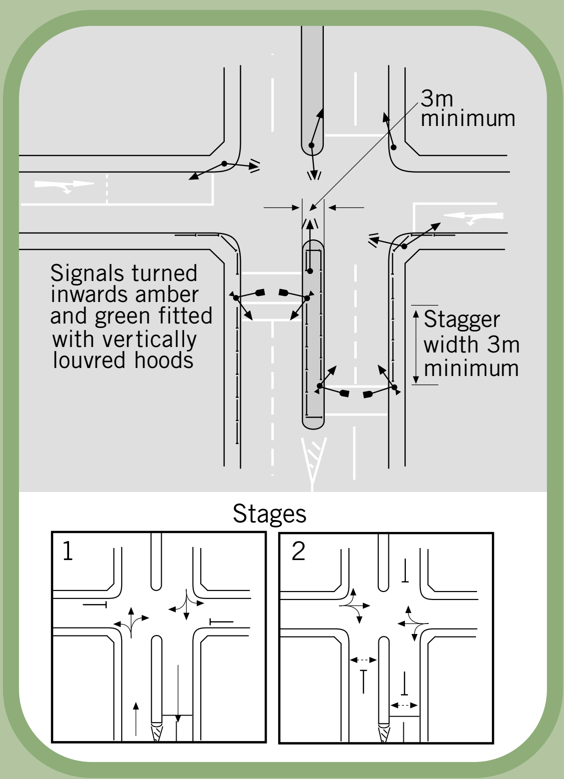


Diagram 10.15 Staggered pedestrian facility



more traditional guardrails can block intervisibility between drivers and child pedestrians. The length of guardrail used should be kept to a minimum to reduce its environmental impact.

Flashing amber for turning vehicles

Dished crossings

Dished crossings should be provided at locations where pedestrians will cross regardless of the provision of a pedestrian phase. The crossings should be ramped or dished at a slope of 1 in 20 where possible. In many urban locations this is not possible so a compromise of 1 in 12 is a more practical maximum slope (see Diagram 13.1).

The upstand between the dropped kerb and the road is an important issue for wheelchair users. Even relatively small upstands can cause the front wheels of wheelchairs to turn and present users with difficulties. Ideally the road surface should be level with the kerb at the dished crossing but the maximum upstand should be 6mm.

Appropriate tactile paving should be provided at all crossing points (see Chapter 13).

Full pedestrian stage

A full pedestrian stage (all-red to vehicular traffic) is the simplest method for pedestrians as they can cross any of the approaches during the stage. However, the introduction of a full pedestrian stage can increase traffic delays considerably, particularly if the approach roads are wide (because of the extra time required for pedestrians to cross) or the junction is near to its capacity. Push button units should be included on signal poles on islands (see Diagram 10.13). Appropriate audible bleepers should be incorporated into the signal equipment (see Chapter 13.4).

Parallel pedestrian stage ("Walk with traffic")

It is sometimes possible to provide a parallel pedestrian stage, known as a "walk with traffic" system. This involves providing a controlled crossing for pedestrians across part of the junction whilst some of the traffic movements (not in conflict with the pedestrian movement) are allowed to run at the same time Diagram 10.14 shows a layout incorporating 'walk with traffic' where turning movements are banned. This facility has the advantage of having less effect on traffic capacity. However there is a tendency to install these facilities where they won't cause problems with traffic rather than where they are most needed by pedestrians. These facilities can be used with banned turning movements and across the exit from one-way streets.

Staggered pedestrian facility (Primary or District Distributor roads only)

In this arrangement a wide central island is provided and the crossing of the road takes place in two separate movements. The crossing walkways are staggered to emphasise that the crossings are separate (see Diagram 10.15). A minimum stagger distance of 3m is recommended. Where possible it is good practice to have the stagger orientated so that pedestrians on the island are walking towards oncoming traffic. This was not possible in Diagram 10.15 where storage is provided in advance of the pedestrian lights for vehicles turning left and right from the minor road. The island must have adequate room for the number of pedestrians that are likely to use it at peak pedestrian times. A minimum island width of 3m is recommended. This allows for a 2m wide walkway, pedestrian guardrail and adequate clearance from the road. Increasing the stagger distance and width of the crossing walkways can help to cater for more pedestrians.

In signalised staggered t-junctions, it may be more appropriate to bring up the pedestrian phase after the main road, and in advance of the side road movements, to avoid car-pedestrian conflicts.

TABLE 10.3 SELECTION OF APPROPRIATE PEDESTRIAN CROSSING FACILITIES AT TRAFFIC SIGNAL JUNCTIONS

PEDESTRIAN FACILITY	COMMENTS
Full pedestrian stage "All-red" to traffic	This is the most common type of pedestrian crossing facility and the simplest for all road users to understand. Should be provided wherever there is available capacity
Parallel pedestrian stage "Walk with traffic"	This provides an opportunity to introduce pedestrian crossing phases whilst allowing traffic movements (that do not conflict with the pedestrian phases) to continue. They can be introduced at sites where the provision of a full pedestrian stage would result in unacceptable delays to traffic. These are often introduced in conjunction with banned turning movements or one-way streets
Staggered pedestrian facility (Distributor roads only)	This allows pedestrians to cross wide roads in two separate movements using a wider elongated central island. Traffic movements that do not conflict with the pedestrian phase are allowed to run at the same time. These offer the advantage that overall pedestrian delay can be reduced and pedestrian safety improved

10.8 Providing for cyclists

Cyclists are vulnerable at all junctions. At traffic signals many cyclists will try to squeeze past lines of queuing traffic to get to the front of the queue. Narrow lanes or multiple lane approaches and the absence of cycle tracks make them particularly vulnerable. Cyclists are at risk from turning traffic.

Cycle tracks can be provided either off-road or on-road. Additionally there will be locations where there are no specific cycle facilities on the approaches to the signals, but cyclists will use the signals. To cater for cyclists at signalised junctions, signal times should be less that 90 seconds.

Most cycle facilities at traffic signals will cross cyclists through the junction on the road.

An advance stop line (see Diagram 10.16) creates an area in front of the normal stop line, to enable cyclists to get in front of other traffic when the signals are red. This allows them to get into a more prominent position. The reservoir area should be about 4m long. It is important to provide cycle "feeder" lanes on the approach to the advance stop lines.

"Provision of cycle facilities, the National Manual for Urban Areas",[8] deals with the provision of facilities for cyclists at traffic signal junctions in detail.

10.9 Providing for buses

Traffic signals can give priority to buses in a variety of ways. The simplest way is to design the signals to give more time to the approaches with bus routes. Alternatively, the buses can be equipped with transponders, which can call and extend the signal phase for the approaching bus. These can only give limited priority to buses unless there is sufficient capacity at the junction to allow bus lanes to continue up to the signal stop line. However the latter may not be possible where left turning vehicles must be accommodated at the junction. Such left turning vehicles can be accommodated either by having a separate left turn lane or by terminating the bus lane in advance of the junction and permitting only left turn traffic and buses in the inner lane from that point to the junction. As a minimum this latter level of priority should be provided on Quality Bus Corridors.

Diagram 10.16 Advanced cycle stop line

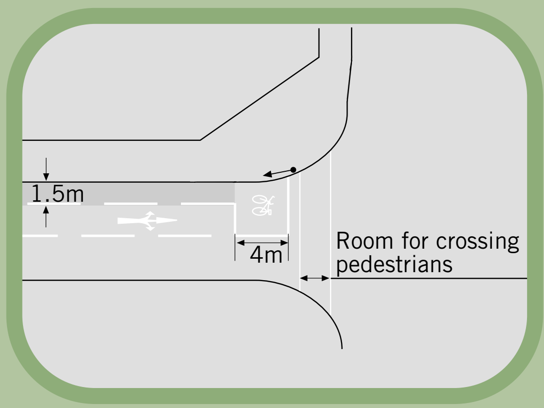
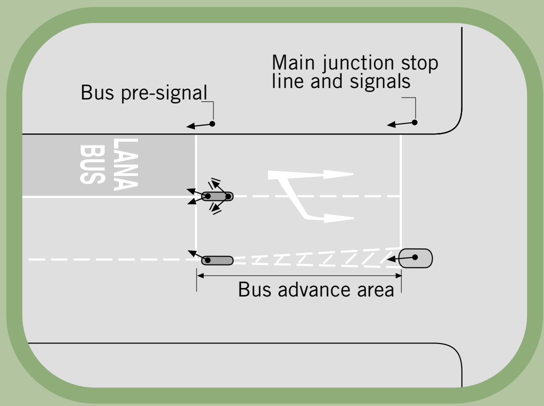


Diagram 10.17 Bus Advance Area which facilitates right turn for buses



Bus lanes and Pre-signals

Where separate lanes can be provided for buses (often on wider roads) there are a number of ways in which buses can be given priority.

- Bus advance area (Diagram 10.17) – which uses a bus pre-signal to allow buses to advance into an area of road that is clear of traffic, before general traffic is allowed to flow. Pre-signals are located prior to the main signals on the approach. The pre-signal holds general traffic on red while the buses are allowed to enter the advance area. The main signal turns to green and traffic flows as normal. This facility allows buses to get to the front of the queue or in position to make a right turn without being held up by the other traffic. This provides a higher degree of bus priority without affecting capacity significantly because the manoeuvring between the pre-signal and signal takes place whilst other traffic phases at the junction continue as normal.
- Bus gate (virtual bus lane, Diagram 10.18) – use separate traffic signals to 'gate' general traffic whilst buses proceed unhindered into a normal traffic lane without having to filter in. These help to reduce delay to buses at locations where the road reduces in width and the separate bus lane has to be terminated. The section of road beyond the signals is then referred to as the 'virtual bus lane'. This area should be kept as "free flowing" (through the use of rear queue detection where necessary)

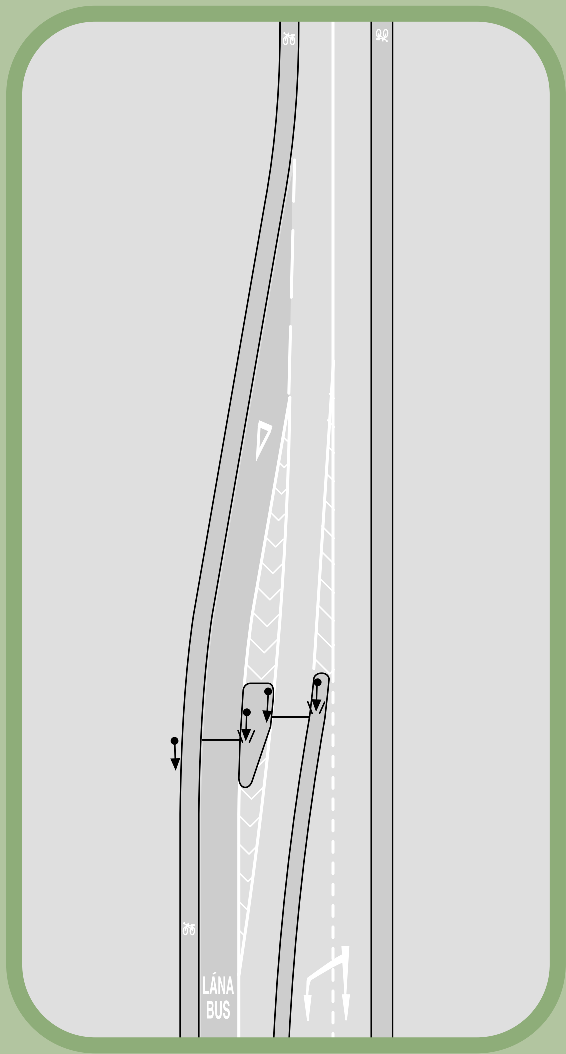
Where left-turning traffic would have to cross a bus lane at a signal controlled junction the bus lane marking can be broken to allow vehicles to do this.

Other bus priority measures

If a bus lane can be continued to the stop line, separate phases can be introduced specifically for buses. When buses are detected, priority can be given to the phase that allows their movement. Selective Vehicle Detection (SVD) can provide a facility for buses to call a phase, which gives them priority. It can also omit or shorten other phases. There are a variety of ways in which this can be achieved. The most common types in use involve either bus-mounted transponders or separate detection loops.

Priority for buses can be provided within linked signals in an UTC system in certain circumstances. This can be achieved by weighting links with significant bus flows in the time plans.

Diagram 10.18 Bus Gate (virtual bus lane)



Bus Priority Measure

Adaptive systems such as SCOOT and SCATS can also give priority to buses within their operation.

Quality Bus Corridors (QBCs), contra flow bus lanes and other forms of bus gates can provide benefit for buses. These are dealt with in Section F, Chapter 15.

10.10 Traffic control strategies

Traffic signals can be used as a powerful traffic management tool and can be used to achieve a wide range of traffic management objectives. If the network is overloaded, there is an immediate loss of network capacity, with unpredictable journey times, and random queueing and traffic jam events. If access to the network is metered, the network will have spare capacity to allow other strategies to take place, such as the following:

- Bus priority – to give buses priority over other vehicles and reduce delays for buses (see Chapter 10.9).
- Pedestrian and Cycle priority – to give pedestrians and cyclists better facilities particularly when crossing junctions. A reduction in delays and improvement in safety can be achieved (see Chapters 10.7 and 10.8).
- Emergency vehicle green waves – to give emergency service vehicles such as fire appliances and ambulances a sequence of green lights along a particular route or through an area. This can help to reduce response times when attending emergency calls.
- Encourage or discourage particular traffic movements – maximum green times can be varied to influence sensitive traffic movements at particular locations or times of day.
- Incident and special event management – signal timings and phase allocation can be altered to cope with incidents such as road accidents. Special events can generate unusual traffic flow patterns or involve temporary road closures.
- Parking management – parking management systems can be incorporated into adaptive co-ordinated signal systems such as SCATS. These can direct traffic to particular car parks.
- Air quality management – this is becoming increasingly important with the need to improve air quality in certain areas as part of the sustainable approach to transport management.
- Queue re-location and Gating – queue re-location provides for the re-distribution of traffic queues away from sensitive links where they could cause problems, for example where blocking of a link with insufficient stacking space could cause other

Quality Bus Corridor

junctions to lock. Gating is a more sophisticated form of queue relocation that involves predefined limits for links sensitive to queuing. It gradually reduces flow into those links by adapting the green times to allow queues to build up at other junctions where the consequences are not so problematic.

The co-ordination of traffic signal junctions along routes or in areas is required for the effective operation of many of these strategies. This is dealt with in Chapter 10.11.

10.11 Urban Traffic Control (UTC)

UTC systems involve the co-ordination of adjacent traffic signals along a route or in an area. If the junctions are linked together, their timings can be co-ordinated to reduce overall vehicular delay. This offers significant benefits and can allow the introduction of a number of traffic control strategies (see Chapter 10.10).

Co-ordination

Co-ordination is achieved by adopting common cycle times for each set of traffic signals. The amount of green time allocated to each movement will vary. It is possible to have some junctions operating two full cycles (double cycling) in the same time that the remaining junctions operate one full cycle. The time difference between a stream of traffic receiving a green light at one junction and the next one is called the offset. By varying the offset it is possible to co-ordinate the sequence of green lights that a stream of vehicles receives and control progress through the network. UTC systems aim to co-ordinate the interaction of all traffic streams in the network with a minimum of delay overall. If some links within the network are sensitive to queues or it is necessary to provide priority for buses etc. along them, weightings can be given to these links to reduce delays on them. Co-ordination can be achieved by the operation of fixed time plans or traffic responsive control systems.

"Green waves" assume all road users are travelling at uniform uninterrupted speeds. This is generally not the case, except perhaps on some primary distributor roads.

Fixed time systems

These operate by implementing fixed time plans for various times of day for example AM peak, PM peak, off-peak, overnight etc. The plans are generally co-ordinated by use of very accurate time clocks within the signal controllers or by links with a central computer. The signals operate in accordance with the time plans, which can be prepared manually or using computer programs such as TRANSYT. If vehicle detection is provided at the junctions, then the fixed time plans can be switched off overnight (when traffic flows are light). The junctions can run in vehicle actuated mode which is more responsive to off-peak traffic patterns.

Fixed time systems offer significant benefits over operation without co-ordination. However, some of the main problems with fixed time plans are:

- they can become out of date quickly and need a lot of traffic survey work and analysis to keep them up-to-date
- the clocks can get out of synchronisation
- they cannot respond easily to variations in traffic flow

Advantages of co-ordinated systems

The main advantages of adaptive systems are:

- improved monitoring of the signal equipment and any faults
- active bus priority
- special event management
- pedestrian priority

On Primary Distributor roads, they can provide the following benefits under certain conditions:

- savings in journey time
- reduction in the number of stops improving fuel economy and reducing pollution

- reduced journey time for emergency vehicles through "green waves"
- reducing driver delays and frustration

Disadvantages of co-ordinated systems

- expensive to install and operate
- requires expert hands-on management
- benefits are limited in a congested network

Traffic-responsive systems

A variety of traffic-responsive systems are in use around the world. These systems monitor traffic flows on the network using detectors and change the signal settings accordingly.

SCATS (Sydney Co-ordinated Adaptive Traffic Systems) was developed in New South Wales and is now used to manage many of the traffic signals in Dublin City and in Waterford City. A central computer communicates with individual signal controllers using a modem and dedicated phone lines. Detectors at each intersection measure traffic volumes and flows. These relay information in a real time manner to the central SCATS computer. The SCATS software adapts the signal timings, offsets and phasing in the system as a whole to respond to traffic flows. SCATS seeks to optimise the operation of each individual junction and its co-ordination with others in the network. The system does not require traffic surveys for updating fixed time plans and can provide traffic flow information for other traffic management purposes.

SCOOT

Split Cycle Offset Optimisation Technique (SCOOT) is an adaptive UTC system developed jointly by the Transport Research Laboratory (TRL) in the UK in collaboration with some of the traffic signal system suppliers. The aims of the system are broadly similar to the SCATS system but the detection systems used and optimisation process used are different. SCOOT is used in Cork, Belfast and widely throughout the UK with very good results. The benefits of SCOOT are widely documented.[9]

10.12 Maintenance and fault monitoring

To keep traffic signals operating safely and efficiently it is necessary to have a good maintenance system. Traffic and pedestrian counts should be updated regularly and signal timings updated accordingly after running one of the available computer models (Chapter 10.5).

Detailed records of all signal timings, phases, stages and equipment are generally stored in the maintenance control centre with a copy in the signal controller cabinet. While faults are often reported by An Garda Siochana and members of the public a road authority should be pro-active in detecting faults. Regular inspections should be carried out to ensure that the signals are operating as designed and that any faults are identified and corrected quickly.

Signal maintenance is a specialist area and should only be undertaken by suitably qualified and experienced staff. If an authority does not have this facility then an arrangement with a specialist contractor should be considered. The following issues should be examined:

- a fault reporting and logging system
- a priority rating system for different types of fault
- agreed times for attending faults of different priorities
- a method of monitoring attendance times
- temporary arrangements if the lights are out of commission or have to be switched off for repair
- a schedule of rates for correction of common faults (e.g. bulb out)
- an agreed way of dealing with problems that require longer to correct
- an annual or six-monthly inspection of the condition of the signal equipment condition and programme of routine maintenance.

UTC systems connected to a central computer can monitor and report faults with the signals. Signal junctions in more isolated areas can also be connected to a central remote monitoring system. A fault monitoring system in the maintenance control centre is connected to the signal controller by a phone line. This periodically interrogates the controller and identifies any faults logged. This allows regular monitoring of faults and facilitates corrective action.

10.13 Signalled roundabouts and gyratories

The introduction of traffic signal control at large roundabouts and gyratories can help to:

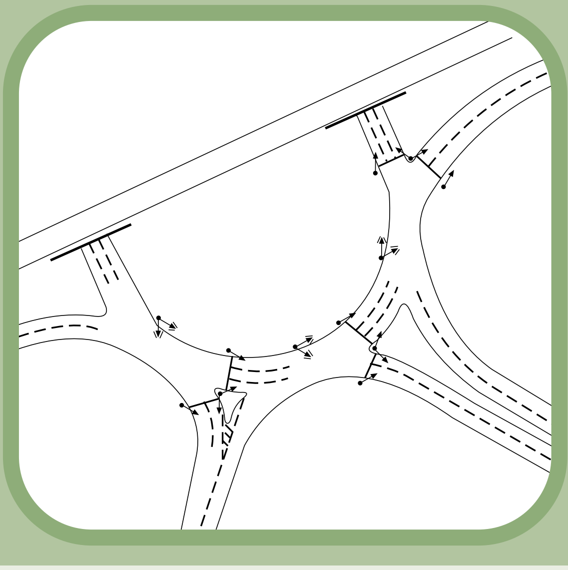
- improve capacity
- balance queues between approaches
- reduce traffic speeds
- improve safety (particularly for cyclists)
- provide controlled crossings for pedestrians and cyclists
- provide priority for public transport including LRT

The junction can be considered as a number of two-stage traffic signals linked together. The first step in the design is to analyse each approach and associated internal stop line as an individual junction. Then, linking the sets of signals is considered. Traffic models (see Chapter 10.5) are needed to assist in this process. One of the main design limitations when considering the introduction of traffic signal control of a roundabout or gyratory is the available queuing lengths within the roundabout itself. If these block then the junction can lock up. It is important to keep cycle times short (no more than 60 seconds) to keep queue lengths to a minimum. It is easier to signalise larger junctions because of this.

An alternative approach that is becoming more popular on complex junctions is to signalise only some of the arms and allow others to work on a yield to traffic from the right basis.

Diagram 10.19 shows an example of a signalled roundabout layout.

Diagram 10.19 Signalled Roundabout



10.14 References

1. RT.181 Geometric Design Guidelines (Intersections at Grade) – National Roads Authority, St Martins House, Waterloo Road, Dublin 4

2. Traffic Signs Manual – Department of the Environment. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

3. TD50/99 and NRA Amendment – NRA Amendment available from NRA, St Martin's House, Waterloo Road, Dublin 4, Ireland. Tel 01 660 2511 Fax 01 668 0009.
TD50/99 available from The Stationery Office, Telephone orders +44 870 600 5522, Fax orders +44 870 600 5533

4. Advice Note TA 16/81, General Principles of Control by Traffic Signals – Available from The Stationery Office, Telephone orders +44 870 600 5522, Fax orders +44 870 600 5533

5. Traffic Advisory Leaflet 3/97, The "MOVA" Signal Control System – (Available from the Traffic Advisory Unit, Zone 3/23, Great Minister House, 76 Marsham Street, London SW1P 4DR Tel +44 20 7944 2478 e-mail: tal@dft.gsi.gov.uk)

6. Advice Note TA15/81, Pedestrian Facilities at Traffic Signal Installations – Available from The Stationery Office, Telephone orders +44 870 600 5522, Fax orders +44 870 600 5533

7. Local Transport Note 1/95 – The Assessment of Pedestrian Crossings, Department of Transport UK. Available from The Stationery Office, PO Box 276, London SW8 5DT.
Tel +44 870 600 5522

8. Provision of Cycle Facilities, National Manual for Urban Areas – DTO/DoELG. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2,
Tel 01 6476879; Fax 01 6476843)

9. Traffic Advisory Leaflet 7/99 – The 'SCOOT' urban traffic control system. (Available from the Traffic Advisory Unit, Zone 3/23, Great Minister House, 76 Marsham Street, London SW1P 4DR Tel +44 20 7944 2478 e-mail: tal@dft.gsi.gov.uk)

11

chapter 11 Roundabouts

11.1 Introduction

The main function of a roundabout is to allow the safe interchange of conflicting traffic movements with the minimum of delay to road users. This is achieved by a combination of geometrical layout features related to the volume, type, and speed of traffic using the junction. The needs of all road users should be taken into account. Traditional roundabout design with flared approaches and wide circulatory carriageway widths is dominated by motor vehicle capacity objectives and this has caused problems for pedestrians and cyclists. On all but the busiest urban roads it is more appropriate to produce designs that are cycle and pedestrian friendly. Where possible continental style roundabouts (see Chapter 11.2) should be used in urban areas. These are smaller roundabouts with single lane entry, circulatory and exit geometry. These help to keep speeds low.

Roundabouts operate most effectively when turning movements are well balanced. This helps to avoid particular traffic streams dominating the roundabout, which can result in delays and drivers taking less safe gaps to get through the junction. Roundabouts are good at coping with high numbers of right turning vehicles and reducing vehicle speeds (if they are well designed).

Roundabout designs need to cope with widely different types of traffic flow and volume. In an urban location, it can be more difficult to meet the full geometric requirements for roundabouts owing to restrictions on available land and vulnerable road users such as pedestrians and cyclists are likely to be present in greater numbers. In a rural location there are normally fewer physical constraints but the traffic will be travelling at higher speeds. The environment where the roundabout is proposed must be assessed to determine if it is the appropriate facility for the location. In an urban situation where traffic signal junctions are the main type of control and a linked traffic signal control system (UTC) is in operation, a roundabout may be totally inappropriate as it could break up a carefully controlled traffic progression plan.

In many European countries roundabouts are increasingly being used as speed reduction measures as well as a tool to denote a change in the road environment such as from dual carriageway to single carriageway, or from a rural to an urban road layout.

This chapter gives general information and advice on the design of roundabouts, which can be used for new junctions or improvements to existing ones. A full roundabout design guide is beyond the scope of the manual but a number of references and sources of information are given in Chapter 11.7.

11.2 Types of roundabout

Four types of roundabout are used:

- Semi-Rural roundabouts (referred to as normal in the Traffic signs manual)
- continental style urban roundabouts
- mini-roundabouts
- double (or multiple) roundabouts

Roundabouts can also form part of grade-separated junctions. Larger roundabouts can be signalled (see Chapter 10.13) if there are congestion problems.

Semi-Rural roundabouts (Diagram 11.1) have a kerbed central island preferably with an 8m to 15m diameter (absolute minimum diameter of 4m) with approaches that flare at the entry to provide sufficient capacity. They usually have 3 or 4 arms. Some roundabouts have 5 or more arms, but the size of the island required to accommodate them often creates problems with the speeds of circulating vehicles. Double roundabouts can be considered as an alternative in such circumstances.
It should be noted that semi-rural roundabouts are so called to distinguish them from Continental style

urban roundabouts. In addition to being suitable for use in certain rural and semi-rural locations, semi-rural roundabouts may also, in certain circumstances, be appropriate for use on Primary Distributor roads in urban and suburban locations.

Continental style urban roundabouts (Diagram 11.2) usually have single lane entries, exits and circulatory areas with a smaller overall size than normal roundabouts. They are more cycle and pedestrian friendly than normal roundabouts because the absence of flaring and reduced widths control entry and circulating speeds more effectively. They are suitable for traffic flows up to a maximum of 20,000 vehicles per day on the major road. Conflicts on the circulatory area and at the exits are reduced. The central island can incorporate a 1.5m wide strip, which can be overrun by long vehicles. Further guidance on designing urban roundabouts is given in Provision of Cycle Facilities, National Manual for Urban Areas.[5]

Mini-roundabouts (Diagram 11.3) have a painted central island (between 1m and 4m in diameter) which can be overrun by long vehicles. These islands are dealt with in detail in Section C.

Double/multiple roundabouts (Diagram 11.4) are combinations of either the normal or mini-roundabout type located closely together. They can also be used in the grade-separated context with a bridge across the main carriageway forming the link between them.

11.3 Principles of roundabout design

Most medium and large roundabouts are designed on computer software packages, which allow the detailed design of both the horizontal and vertical alignment. Roundabouts should be designed to reduce the entry speed of vehicles so that drivers can judge gaps in traffic and can negotiate the junction safely. Roundabouts must also be able to cope with the volumes of traffic that use them. This balance is achieved by a series of geometric layout factors, which are outlined below. Whilst the roundabout geometry is the most influential safety factor, other factors such as signing, road markings, lighting, landscaping and the provision of facilities for pedestrians and cyclists also have an important role (see Chapter 11.6).

Diagram 11.1 Semi-Rural roundabout

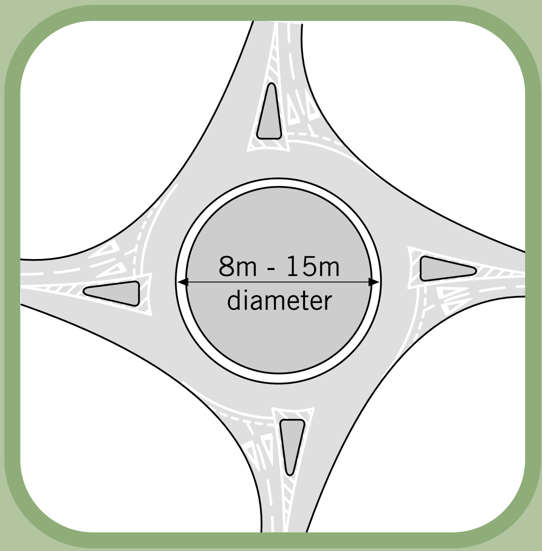


Diagram 11.2 Continental style Urban roundabout

The information in this chapter should be read in conjunction with TD16/93[1] – Geometric Design of Roundabouts and NRA addendum, and the relevant section of Provision of Cycle Facilities, National Manual for Urban Areas.[5]

Continental design roundabouts[5] are the recommended type of roundabout for urban areas for roads with less than 20,000 vehicles per day (subject to a capacity assessment).

Size and shape

The central island of a roundabout should be circular in shape. The size of a roundabout is measured by its outside diameter and this is referred to as the Inscribed Circle Diameter (ICD). This should meet all the kerb lines at the entry points. A constant circulatory width should also be achieved where possible. Traffic on non-circular roundabouts does not flow smoothly, braking and accelerating is accentuated and can lead to accidents.

Continental design roundabouts have a smaller ICD (25m–40m) than normal roundabouts. This makes it easier to achieve geometric requirements.

On roads requiring a higher traffic capacity junctions, an ICD of between 45m and 60m, with 2 or 3 circulating lanes (8m to 12m) is needed. For layouts with 5 or more arms, the roundabouts increase in size markedly. Experience at larger roundabouts has shown that too wide a circulating width can result in excessive speed, driver confusion and resulting safety problems. It is conventional practice to design the circulatory width to a ratio of between 1.0 to 1.2 times the maximum entry width. A maximum circulatory width of 12m is generally considered to be the safe upper limit unless other design factors, such as signalised entries or special circulatory markings, are proposed.

Vehicle entry path curvature (Semi-Rural roundabouts only)

Vehicle entry path curvature (Diagram 11.6) on the approach to the roundabout has a major influence on safety as together with the entry width it controls the speed at which a vehicle enters the roundabout.

Diagram 11.3 Mini-roundabout

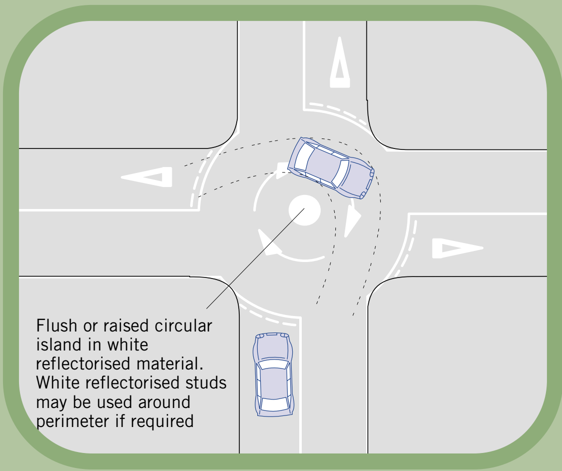


Diagram 11.4 Double roundabout

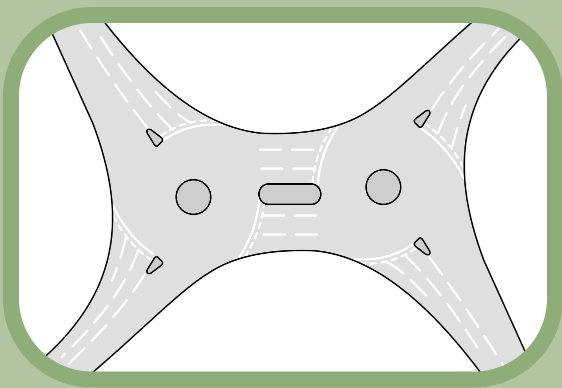
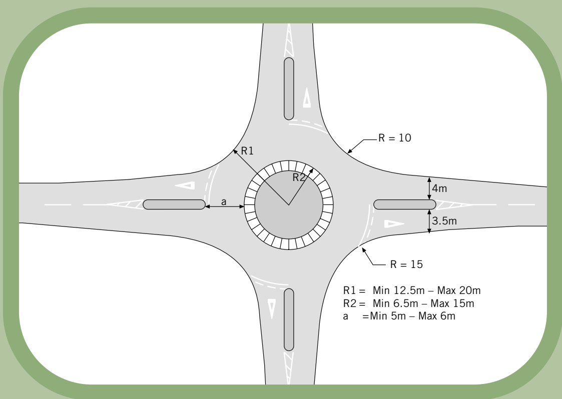


Diagram 11.5 Basic dimension of continental design roundabout



Entry path curvature is a measure of the amount of deflection to the left that the driver is forced to take when entering the roundabout. A vehicle path with a radius of not more than 100m is recognised as achieving the appropriate minimum amount of deflection. It is essential that this deflection be achieved at the entry point to the roundabout. If the entry path curvature is too severe it can result in vehicles losing control and mounting the central island. Similarly this can make it difficult for drivers to merge with traffic on the circulatory carriageway as they may be brought on at such an angle as to make speed and gap assessment difficult.

Entry Angle (Semi-Rural roundabouts only)

The entry angle (Diagram 11.7) is the angle of a vehicle approaching a roundabout in relation to the angle of traffic circulating. Too sharp an entry angle can reduce capacity whilst too shallow an angle can lead to faster entry speeds. An entry angle of 30 degrees is the optimum but this can vary from 20 degrees to 60 degrees, depending on design constraints.

Methods for measuring entry path curvature and entry angle together with examples for different types of roundabouts are given in TD16/93[1] – Geometric design of roundabouts and NRA addendum.

Entry width, lane width and corner radii (Semi-Rural roundabouts only)

The entry width is the width of an approach as it enters the roundabout circulatory area. Traditional roundabout design allows for localised widening on the entry arms from 1 to 2 lanes or from 2 to 3 or 4 lanes to improve capacity. Care needs to be taken that the entry width provided is not excessive as this can make it difficult to achieve the required entry path deflection. Drivers are often reluctant to use this extra width for fear of being involved in weaving collisions as they enter the circulatory carriageway.

Capacity calculations from computer models (see Chapter 11.5) may suggest the need for three (or more) lanes at an entry for a particular design year flow. In the early years of operation this width may be unnecessary and some of it may not be used. In such cases it is appropriate to restrict entry width by white lining until growth in traffic flow requires the extra width. Wide approaches also disadvantage pedestrians attempting to cross at

Diagram 11.6 Entry path curvature for a semi-rural roundabout

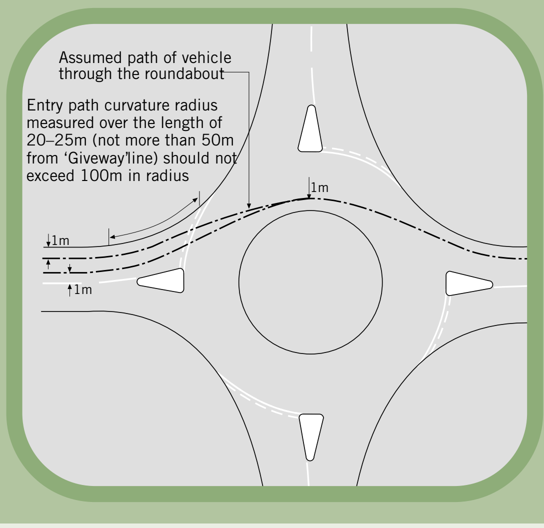
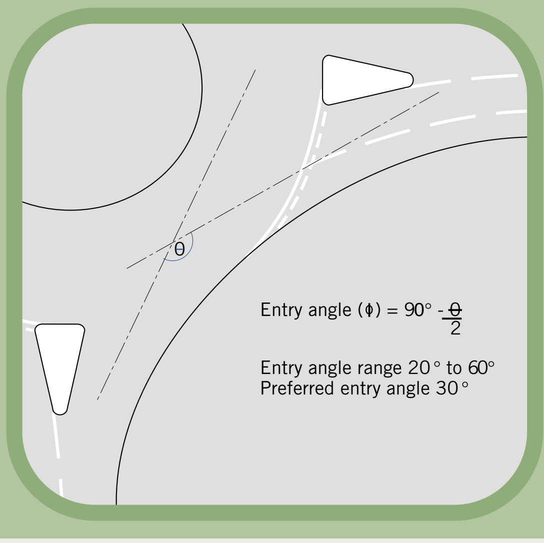


Diagram 11.7 Entry angle for a semi-rural roundabout



the junction and encourage high entry speeds in light traffic conditions. Where more than one lane is provided, lane widths should be between 3m and 3.5m at the entry yield line.

Splitter Islands

Splitter islands should be provided on approaches (where possible) as they assist pedestrian crossing movements and can accommodate signing to direct traffic. The recommended width between kerbs should be approximately 4m for continental style roundabouts and 6m for normal roundabouts. Care needs to be taken that the signs do not block the visibility of pedestrians.

The recommended kerb radii at entry and exit on a semi-rural roundabout are summarised in Diagram 11.8

Visibility

There are a number of visibility requirements for good design and safe operation:

- Advance visibility (Diagram 11.9) of the roundabout for drivers on the approach (see Table 11.1) is essential for drivers to anticipate the exact location of the roundabout. If drivers cannot see the roundabout because it is hidden over a crest or around a curve then they may not be able to yield at the entry.
- Visibility to the right (Diagram 11.10) and across the circulatory area for vehicles at the yield line is essential in order for drivers to detect safe gaps in traffic. If drivers are unable to see sufficiently then they may be hit by circulating vehicles as they enter the roundabout. However, being able to see to the right from too far back on the approach can encourage drivers to enter the roundabout too quickly. In order to counteract this the required visibility to the right should only be available from a point some 15m back from the yield line. In the UK some authorities have erected fencing or provided landscaping on the approaches to limit visibility.

Further advice on visibility distances is given in TD 16/93[1] and NRA addendum.

Diagram 11.8 Entry width, lane width and corner radii for semi-rural roundabout

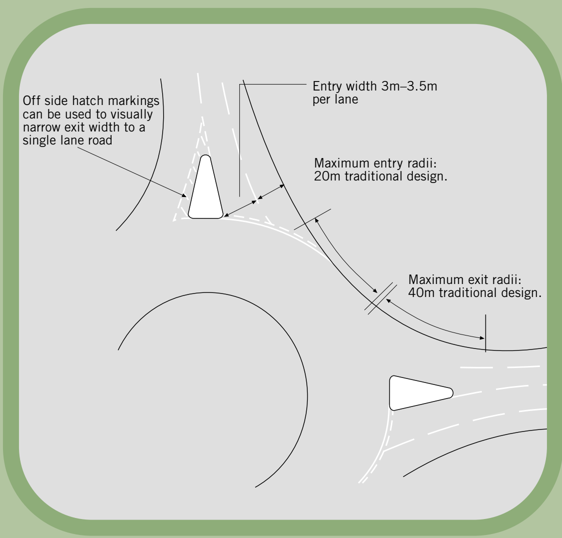


Diagram 11.9 Advance visibility required

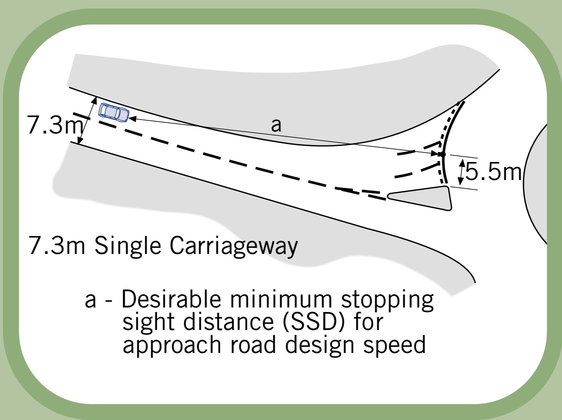


Table.11.1 Recommended advance and forward visibility distances

85% APPROACH SPEED (KPH)	DESIRABLE MINIMUM VISIBILITY DISTANCE (a) (metres)
40	40
50	70
60	90
80	145
100	215
120	295

11.4 Road markings and signing

It is necessary to provide adequate signing and road markings to warn drivers of the presence of a roundabout as they approach it. This is achieved by providing adequate visibility of the roundabout (Chapter 11.3) and the associated signs and road markings. The central island of the roundabout should have 'turn left' and 'sharp change of direction' signs facing each entry in addition to the required lane and yield markings. On the approaches, map-type direction signs (accurately reflecting the layout of the junction) should be used in advance of the roundabout. These should be supplemented by 'roundabout ahead' warning signs, where appropriate.

For roundabouts with high-speed approaches and those where the required advance visibility distance cannot be obtained a number of additional measures can be considered:

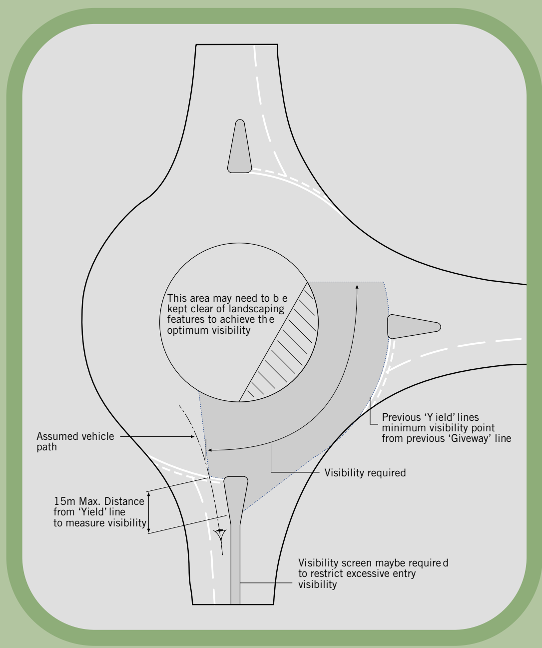
- the inclusion of 'reduce speed now' supplementary plates with the roundabout warning signs
- the use of 'III, II, I' countdown marker posts on the approach
- the use of coloured rumble strips on the approach
- the use of 'slow' markings on the carriageway

These signs and road markings can help to reduce accidents.

Road markings can help drivers to get into the correct lane on the approach to the roundabout. Larger roundabouts or those with three or more circulating lanes can be confusing for drivers in the absence of lane use guidance. It may also be advantageous to provide lane markings on the circulatory area to promote good lane discipline. TA 78/97[2] – Design of road markings at roundabouts shows examples of how circulatory markings can be used at roundabouts (see Diagram 11.11).

Advice on the use of signs for roundabouts is given in the Traffic Signs Manual.[3]

Diagram 11.10 Visibility to right and across circulatory area



Transverse strips on roundabout approach

11.5 Capacity issues and computer models

In capacity terms, new roundabouts are designed to cater for flows in a 'design year' some 10 or 15 years in the future (taking into account traffic flow growth). However as traffic increases it is increasing difficult to accommodate this, especially in urban areas. Often the best that can be achieved at a particular site is to optimise the capacity of the junction within the constraints imposed by available land, services diversion costs and the available budget. The latter approach can lead to pressure to compromise some of the geometric layout features essential for safe operation of the roundabout (such as entry path deflection and entry angle). Such pressures should be resisted and alternatives such as the use of overrun areas and alternative forms of junction should be considered.

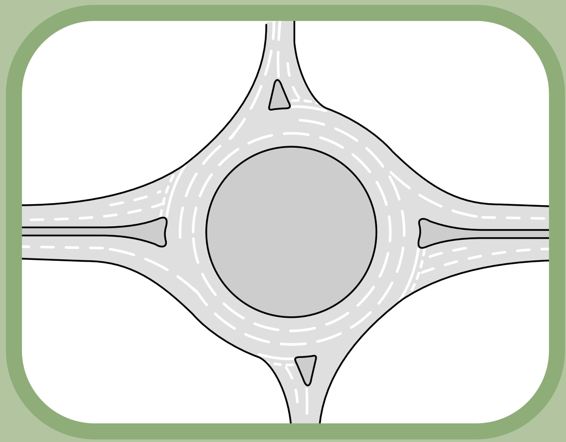
Capacity calculations for semi-rural roundabouts are undertaken using computer software packages. The two main software packages in use are ARCADY and RODEL. These operate in a similar way but ARCADY is more commonly used and can produce predictions of accidents (based on UK experience). Both of these packages use a number of geometric parameters to enable roundabout designs to be modelled against a range of predicted traffic flows to ensure that it will operate satisfactorily. The models output information on queues, delays and capacity (RFC – Ratio of Flow to Capacity) for each arm of the junction. Ideally the RFC value for each arm should be less than 0.85 to produce an efficient design. One or more of the following can achieve improvements in capacity:

- widening the approaches
- increasing the length over which the widening is developed (flare length)
- increasing the size of the roundabout (ICD)

The computer models allow these effects to be tested to optimise the capacity of a particular design.

As with all computer models, care is needed with the interpretation of the results and it is necessary to check that the overall design still produces safe and acceptable operating

Diagram 11.11 Example of circulatory markings on roundabout



Roundabout without adequate entry deflection characteristics. It is not acceptable to provide a roundabout that has adequate capacity but does not have safe operating characteristics in order to minimise cost.

Unfortunately, neither of these computer models consider the needs of vulnerable road users in the design process and any outputs of accident rates should be checked against local control data to ensure that they are applicable to local conditions.

11.6 Safety issues

Well-designed roundabouts have a good safety record.[4] However, there can be financial and site constraint pressures to provide layouts that may not perform as safely.

The most common accident types at roundabouts involve either a vehicle entering the roundabout into the path of a circulating vehicle or nose to tail shunts on the approaches. Many accidents are related to the speed at which traffic enters a roundabout. High entry speeds lead to high circulating speeds. The most significant design factors, which lead to this, are:

- insufficient entry deflection (Chapter 11.3)
- shallow entry angles (Chapter 11.3)
- inadequate advance visibility of the roundabout and to the right at roundabout yield markings (Chapter 11.3)
- excessive visibility on approaches (Chapter 11.3)
- excessive approach speed (Chapter 11.4)

Other safety problems at roundabouts include:

- high proportion of accidents involving two-wheeled vehicles (around 50% in the UK), leading to consideration of continental style design as a more acceptable solution.
- inadequate surface skidding resistance on the circulatory and approaches – these areas are subject to high braking and turning forces and require the provision of a surface with a high skidding resistance
- large roundabouts (ICDs greater than 80m) with five or more arms have significantly more accidents than smaller ones.
- on some roundabouts sharp changes in crossfall (often combined with tight entry or exit radii) can lead to trucks shedding loads or overturning.

Two-wheeled vehicles are vulnerable and have a very poor injury accident record at all types of roundabouts. The reduction of entry speeds at roundabouts can help to improve safety but consideration should be given to the provision of specific facilities for cyclists at roundabouts. Advice on this is given in 'Provision of Cycle Facilities, National Manual for Urban Areas[5]'.

Roundabouts should not be used in areas of high pedestrian movement unless specific controlled crossing facilities are provided on the approaches. Where crossing facilities cannot be justified, splitter islands should be provided on approaches to assist pedestrian crossing movements. Care needs to be taken that any signs on these islands do not block the visibility or desire lines of pedestrians.

Landscaping can help make a feature of roundabouts and integrate them into the surrounding urban scene, provided that essential visibility elements, traffic signs and other features are not obstructed.

Roundabouts are excellent gateways and are a useful map reference particularly if designed as recognisable urban landmarks.

Road safety audits should be carried out on the designs of all new roundabouts and roundabouts that are being improved significantly.

11.7 References

1. TD16/93 – Geometric Design of Roundabouts and NRA addendum – NRA addendum available from NRA, St Martin's House, Waterloo Road, Dublin 4, Ireland. Tel 01 660 2511 Fax 01 668 0009. TD16/93 available from The Stationery Office, Telephone orders +44 870 600 5522, Fax orders +44 870 600 5533

2. TA78/97 – Road markings at roundabouts – Highways Agency (UK), Available as part of Design Manual for Roads and Bridges, Volume 6 from The Stationery Office, PO Box 276, London SW8 5DT. Tel +44 870 600 5522, Fax +44 870 600 5533

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section e Vulnerable Road User

12

chapter 12 Facilities for Pedestrians, Cyclists and Motorcyclists

12.1 Duties and responsibilities

The 1993 Roads Act[1] requires Road Authorities to consider the needs of all road users when constructing and maintaining public roads. For traffic engineers involved in the design, construction and maintenance of traffic management schemes there is a clear implication that due consideration should be given to all road users.

Vulnerable road users – pedestrians, cyclists, children, the elderly, and those with a mobility impairment may require special consideration within traffic management schemes and the provision of specific facilities on the road. The 1993 Roads Act also requires all road users to take reasonable care for their own safety and that of others when using public roads.

The 1997 Road Traffic (Traffic and Parking) Regulations,[2] requires that pedestrians exercise care and take all reasonable precautions in order to avoid causing danger or inconvenience to traffic and other pedestrians. Where pedestrian crossings are provided, pedestrians are required to use them. Pedal cyclists are required to ride no more than two abreast in the roadway (except when overtaking other cyclists).

The 1997 Road Traffic (Signs) Regulations[3] and Traffic Signs Manual[4] give details of the requirements for signs and road markings at pedestrian crossings.

"Provision of cycle facilities – National Manual for urban areas"[8] gives comprehensive guidance on the provision of cycle facilities. The Cycle manual is currently being reviewed and it is expected that it will be updated by the end of 2003.

12.2 Promoting walking and cycling

In general, the minimum width of a new footway should be 1.8 metres.Wider footways should be provided where there are higher pedestrian flows. Where an existing street is being improved, consideration should be given to widening inadequate footways.

During the past two decades there has been a considerable decline in walking and cycling as modes of travel.

More recently cycling along some routes has increased with the provision of cycle facilities.

There are many possible reasons for the long term decline in walking and cycling including:

- increased car ownership
- economic growth and increased employment
- reduced reliability of public transport
- motor vehicle dominated road design
- concerns about personal security
- speed and volume of motor traffic leading to concerns about road safety
- closure of public rights of way
- poor planning resulting in longer distances to shops, schools, etc.

In order to reverse this downward trend it will be necessary for roads authorities to adopt polices that actively promote walking and cycling. These policies need to recognise the role that walking in particular plays in integrating other modes of transport. Surveys have revealed a substantial latent demand for more cycling and walking if better facilities are provided.

Safe networks of walking routes are required to key attractions, public transport access points, and urban centres. A local walking strategy can be developed in partnership with other public bodies, commercial organisations, voluntary groups and the wider community.

Walking and cycling can be promoted through steps taken within the planning process thereby reducing the need to travel by private motor car (see Section A, Chapters 1.5 and 1.7).

Businesses and schools can be encouraged to adopt Travel Management Plans (Chapter 1.5) setting out strategies for reducing car trips and increasing other more sustainable modes of travel. "Safer routes to schools" projects and local traffic calming schemes can help to increase walking and cycling trips in local residential areas.

In making infrastructure improvements to encourage walking and cycling, road authorities will need to address the following issues:

- the need to reduce the dominance of motor traffic
- the provision of pedestrian priority measures
- the provision of better walking and cycling facilities
- the provision of more and safer crossing facilities
- a reduction in the volume and speed of motor traffic
- a reduction in the obstruction of footways and cycle tracks caused by parked vehicles and street furniture
- improved maintenance of footways and cycle tracks
- improved lighting for footways and cycle tracks
- improved signing for pedestrians and cyclists
- the provision of specific facilities for people with a mobility impairment
- pedestrian, cycle and mobility audits (see Chapter 14)
- a reduction in the fear of street crime and concern about personal safety

This chapter concentrates on guidance for the provision and improvement of specific crossing facilities for pedestrians and cyclists.

Pedestrian/cycle bridges and subways are only suitable when the topography of the surrounding area provides pedestrians and cycles with a direct route with no significant gradients, and where personal security is not a perceived risk.

If pedestrian/cycle bridges and subways are provided at other locations they will not be attractive to use. There may be resultant safety problems because pedestrians and cyclists will continue to cross at ground level.

On road cycle track

Footway widths and bollards

In urban areas, the normal minimum width of a footway should be 1.8m. It is important that the effective width of the footpath is preserved for pedestrians. The presence of street furniture (poles, bollards, seats etc.) reduces the effective width considerably, and can create significant obstacles for vision-impaired persons.

In particular, bollards should be used sparingly, and only in situations where they do not create obstacles for pedestrians. On high-flow pedestrian routes, inappropriately placed bollards can result in pedestrians walking out onto the carriageway, encroaching on the path of moving vehicles. Other methods of defining the limit of the road or precluding car parking on footways (such as high kerbs, enforcement, etc) may be more appropriate, as these retain the pedestrian capacity of the footway.

12.3 Controlled crossings

In order to achieve broad aims of sustainable transport, it is important that walking and cycling are encouraged. Roads, particularly those with high traffic volumes, are seen by many people as barriers to walking and cycling and there are increasing demands for the provision of good crossing facilities.

Guidance on the justification for a controlled pedestrian crossing and the most appropriate type of crossing facility is given in Local Transport Note 1/95[7]. The old system of warrants is now 30 years old and has been superseded. In the climate of encouraging walking as part of sustainable transport, justification for pedestrian facilities tends to be made more in terms of the needs of pedestrians (in particular the delays and difficulties experienced in crossing a road).

It can sometimes be difficult to provide adequate signalled facilities for pedestrians without having adverse effects on peak hour traffic queues and delays.

Factors to consider in assessing the need for a pedestrian crossing

There are a number of factors that should be considered before introducing a pedestrian/cycle crossing facility. These factors include:

- volume and speed of traffic
- volume and age profile of pedestrians and cyclists
- road, cycle track and footway widths
- difficulty in crossing the road
- delay in crossing the road
- road accident records
- requests for crossing facilities

Advice on the provision of crossings for cyclists is also given in the "Provision of cycling facilities – National Manual for Urban Areas[8]".

Types of controlled crossings

There are a number of options for introducing controlled crossings. These are zebra, pelican, puffin, toucan crossings and pedestrian stages at traffic signals. Puffin crossings respond better to the needs of both pedestrians and drivers and consideration should be given to using them at locations where pelican crossings would traditionally be considered appropriate. Pedestrian stages are dealt with in Chapter 10.7. Crossings can be introduced either in isolation or as part of other schemes such as traffic calming schemes or environmental cells. The crossings themselves can be placed on top of raised tables if required. This can help to reduce approach speeds and reduce pedestrians concerns about crossing the road.

Zebra crossings[4] rely on drivers giving way to pedestrians who step out onto the crossing. They cause little delay to pedestrians and are generally used in the following cases:

- where traffic speeds are low (85% speeds less than 35mph)
- where traffic volumes are moderate
- as part of traffic calming schemes
- where the carriageway width does not exceed 7 metres

At sites with high traffic volumes or high approach speeds it may be difficult for less able (such as the elderly or mobility/sensory impaired) or less confident (such as younger children) pedestrians to gain precedence.

Details of the road markings for a Zebra Crossing Complex are shown in Diagram 12.1 (figure 7.30 of the Traffic Signs Manual[8]). High-friction surfaces should be considered for each approach (see Chapter 12.6). Zebra crossings can assist with transport policy objectives such as traffic reduction or speed reduction on local roads.

The minimum width of a zebra crossing is 2.4m, although greater widths (up to 5m) should be used when there are high pedestrian flows or the footways are narrow.

Zebra crossings can be sited close to junctions, at a minimum recommended distance of 5m away. Zebra crossings are useful on low speed approaches to urban roundabouts and avoid any potential confusion for drivers that can occur with signalled crossings close to the yield line.

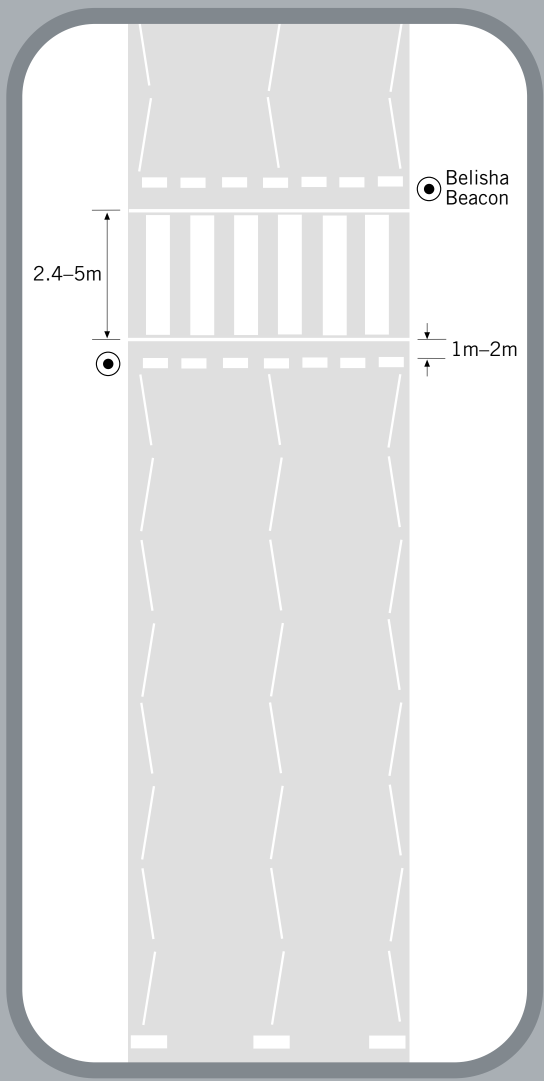
Parking is prohibited within 15m on the approach side or 5m on the side other than the approach side of a section of road where any of the following have been provided:

- Pedestrian Crossing (no zig-zag markings)
- Pedestrian Crossing Complex (has zig-zag markings)
- Traffic/Pedestrian Signals

The standard marking for a pedestrian crossing complex is 8 x 2m zig-zag marks. There may be situations where it may not be possible to install all of these marks because of site constraints. Similarly if there are problems with approach visibility or speed then the number of markings can be extended up to a maximum of 18 markings. On carriageways less than 6m wide, two zig-zag lines (one at each side of the road) with a solid line down the centre should be used. On roads wider than 6m a third zig-zag line should replace the central hazard line.

Belisha beacons must be provided at all zebra crossings They increase the conspicuity of the crossing. Belisha beacons should be located on the nearside footway of each approach adjacent to the crossing. The beacons should flash at regular intervals at a rate of between 35 and 45 flashes per minute.

Diagram 12.1 Zebra Crossing complex



Pedestrian aspects

Pelican crossings[4] give positive signal control to both pedestrians and drivers.

They use far-side pedestrian signal heads (which should incorporate an amber pedestrian aspect in all new installations) and near-side push button units (see Diagram 12.2).

The sequence of pedestrian lights is red, green, amber then red again. The green pedestrian aspect time is usually fixed at 6 seconds and is an invitation for pedestrians to start to cross the road. The amber pedestrian aspect varies with the width of the road, allowing a second for each 1.2m of road width that pedestrians cross. The amber aspect indicates that pedestrians can complete their crossing manoeuvre but should not start to cross. All red periods of 2 seconds should be allowed at the beginning and end of the pedestrian signal sequence.

The majority of pelican crossings are situated on roads with a speed limit of 40mph or less. Speed discrimination or assessment detection may be necessary for 85 percentile approach speeds in excess of 35mph.[9] Pelican crossings can be used on roads with high traffic volumes and where pedestrian flows are high. Pelican crossings tend to be more popular with the public and are better for less able or less confident pedestrians. The minimum width of a pelican crossing is 2.4m, although greater widths (up to 5m) should be used when there are high pedestrian flows or the footways are narrow.

Pelican crossings work more efficiently (from a vehicle point of view) by collecting groups of pedestrians together and crossing them at the same time. This does however result in delays to pedestrians and unless measures are taken to ensure that delays are minimised, pedestrians will be more likely to cross against the red man. Pedestrians should not have to wait longer than 30 to 40 seconds at a pelican crossing and opportunities should be sought to introduce the green pedestrian sequence earlier if traffic conditions allow. This can be achieved in two ways:

- A facility for a **pre-timed maximum** for vehicles can be introduced. If the maximum vehicle green time for vehicles (usually 30 to 40 seconds) has elapsed since a pedestrian demand was last made, then the green man crossing will come in straight away on demand

Diagram 12.2 Pelican Crossing

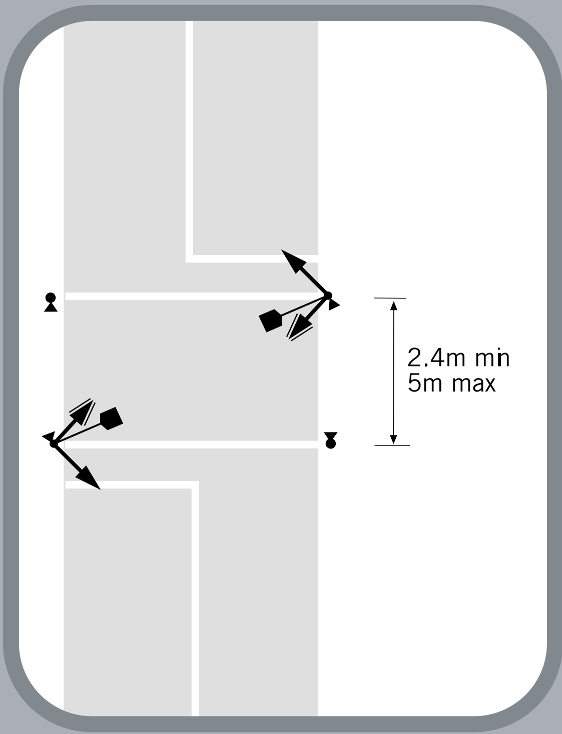
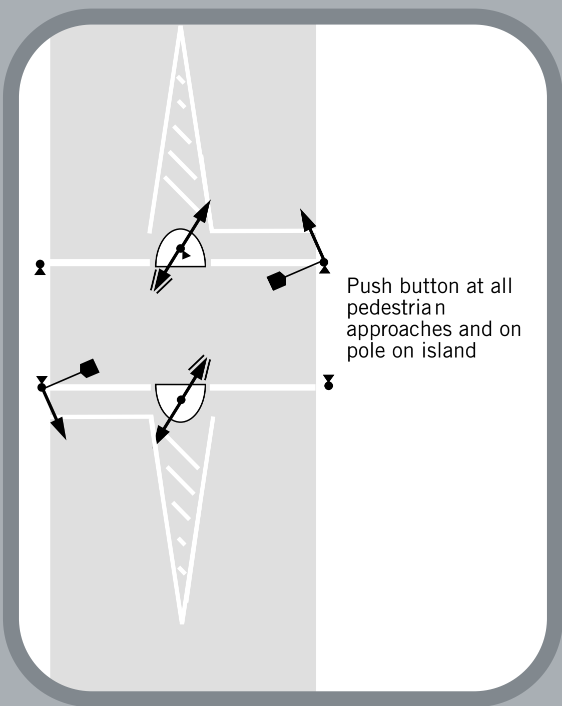


Diagram 12.3 Splitter island at Pelican



- **Detectors** can be mounted on the traffic signal heads. These detect gaps in traffic and allow an earlier introduction of the green man crossing if there is a gap in traffic

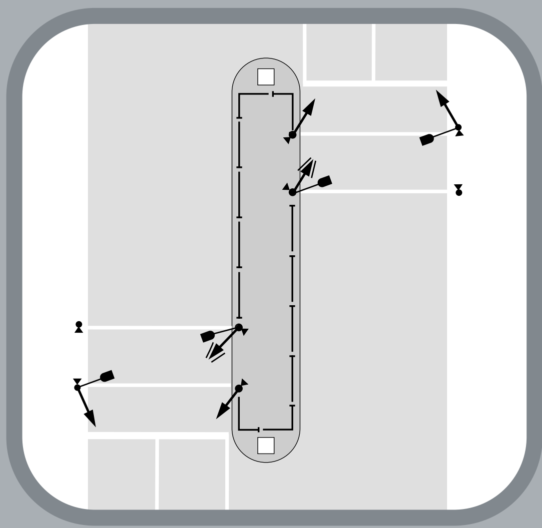
Where roads are wide enough (around 8m or more), traffic islands can be introduced to increase the conspicuity of the crossing by allowing additional primary signal heads to be installed. If traffic islands are used then an additional push button unit should be installed on the signal poles on the island, for use by any slower moving or late crossing pedestrians who did not complete their crossing movements during the first green man phase (See Diagram 12.3).

On wide distributor roads (10m or more) or dual carriageways, consideration should be given to splitting the crossing into two parts and staggering the crossing points (see Diagram 12.4). Where possible, the stagger should be arranged so that pedestrians are walking towards traffic when they are in the central island. This allows pedestrians to see approaching vehicles more easily. The central island needs to be at least 3m wide to ensure that there is sufficient width for pedestrians to pass within the pedestrian guardrails (with the required clearance of 450mm from traffic). These staggered crossings can be more efficient for traffic and safer for pedestrians.

For higher risk sites, a high-friction surface should be considered for each approach to a pelican crossing (see Chapter 12.8).

Puffin crossings[10] have recently been introduced in the UK. Puffin (Pedestrian user friendly intelligent) crossings are similar to pelican crossings but are designed to be more responsive to the needs of both pedestrians and drivers. Detectors fitted to the top of the traffic signal poles are directed at pedestrians on the crossing and can extend the pedestrian crossing time to allow slow moving or large groups of pedestrians (such as school children) sufficient time to cross the road. Pole mounted detectors can also be used to supplement pedestrian push button units. They detect the presence of a pedestrian at the kerbside but will cancel the pedestrian demand if the pedestrian moves away from the crossing point (for example, crosses through a gap in traffic). This helps to prevent unnecessary delays for drivers and the resulting frustration. Puffin crossings

Diagram 12.4 Staggered Pelican Crossing



Puffin crossing

Toucan Crossing

are gradually replacing pelican crossings in the UK. Puffin crossings use near-side pedestrian signal aspects incorporated into the push button units rather than far-side signal heads.

Toucan crossings[11&12] (Two-can-cross) enable pedestrians and cyclists to cross together. Cyclists are not required to dismount and cross on foot unlike the other forms of controlled crossing. They should be used where cycle and pedestrian routes cross main roads. The crossing itself should be a minimum of 4m wide to give adequate room for pedestrians and cyclists. It is important to design the approaches to the crossing to minimise the conflict between cyclists and pedestrians. Separate detection for cyclists may reduce delay time to vehicles, as cyclists will negotiate a junction more quickly than pedestrians. Advice on the provision of crossing facilities for cyclists is given in the Provision of Cycle Facilities, National Manual for Urban Areas[8]. Whenever feasible, dished crossings, tactile paving and audible and tactile indicators should be provided as part of all new signal controlled crossings (See chapter 13). Consultation with organisations representing people with disabilities is advisable prior to the construction of new crossings or the alteration of existing crossings.

Traffic Island

Build-out and speed table

12.4 Uncontrolled crossings

Traffic islands (refuges) are the simplest form of crossing facility. Such facilities provide some protection for pedestrians and enable them to cross one stream of traffic at a time.

A series of traffic islands can be particularly useful where pedestrian crossing movements are not concentrated at one point but are spread along a length of road. In addition they can contribute to reducing traffic speeds and preventing overtaking. Where a traffic island is provided it is important that it is of sufficient width to accommodate pedestrians. Ideally, a 2m-wide island should be provided to accommodate bicycles, prams, pushchairs and wheelchairs. A width of 1.5m is regarded as the minimum for pedestrians, but is not wide enough to accommodate a bicycle. Traffic islands are dealt with in detail in Chapter 6.8.

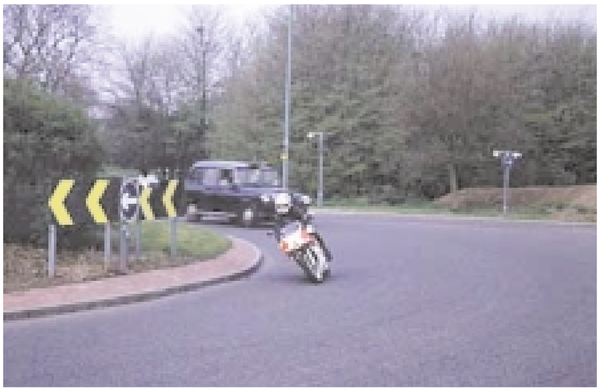
Build-outs and speed tables can also improve the opportunity for pedestrians to cross the road. They can be provided at locations where parking is being sheltered or as a traffic calming feature in its own right (see Chapter 6.12 and 6.13). Pedestrians may have a shorter distance to cross and may have the benefit of reduced vehicle speeds. Build-outs and speed tables can also be incorporated into controlled crossing facilities.

12.5 Issues for motorcyclists

Motorcyclists (including moped and scooter riders) are vulnerable road users because they have little protection if they are involved in an accident with another vehicle. They travel at higher speeds than other vulnerable road users and consequently they are more likely to be seriously injured or killed in an accident. They are involved in a far higher percentage of accidents per trip than other motor vehicles and are particularly vulnerable at junctions where drivers often fail to see them. Although road design cannot address all the problems that motorcyclists face, there are a number of issues that designers, traffic engineers and planners can influence. Some of the main problems are:

- the joints between road surfaces, use of concrete blocks or clay paviours on the carriageway and metal inspection chamber covers on the road can present slip hazards. Jointing materials and blocks should provide an adequate skidding resistance. The siting of inspection covers where riders are likely to be leaning over to turn at a junction
- surface problems such as pot holes, raised "lips" on overrun areas can cause loss of control accidents. Pot holes should be attended to promptly and any changes in surface level should be made conspicuous by use of appropriate markings
- other maintenance problems include leaves and diesel spillages on the carriageway. These should be identified and be treated promptly
- weaving traffic on links and at approaches to junctions may be unaware of the presence of motorcyclists and cyclists and could collide with them or cause them to lose control. Clear and easy to understand signs and road markings in advance of the junction can help to reduce the risk of last minute lane changing

Motorcyclists can also help themselves by ensuring that they display dipped headlights when riding in day time to make themselves more conspicuous to other road users. Road authorities should consider the needs of motorcyclists as part of their transport strategy.



Motorcyclist on roundabout

12.6 Design and safety issues

The design of controlled crossing facilities is dealt with in a number of documents. Chapter 7 of the Traffic Signs Manual[4] gives basic advice on the provision of zebra and pelican crossings. Although some of the signal sequences, aspects and timings in the UK are different from Ireland, Local Transport Note 2/95 (UK) – The Design of Pedestrian Crossings[9], gives useful detailed design advice on the provision of controlled and uncontrolled crossings for pedestrians and cyclists.

Guard Rail blocks visibility

Desire lines and proximity of crossings to junctions

Pedestrians and cyclists want to travel as directly as possible. They do not want to walk or cycle out of their way to use crossings. Significant proportions of pedestrians and cyclists will not inconvenience themselves by travelling the extra distance to formal facilities and may be prepared to take the risk of crossing away from the formal crossing point if they are not guided to them.

High visibility guardrail

Whilst it is impossible to provide crossings to accommodate the needs of every pedestrian and cyclist it is important that crossings are sited where the maximum number of people are likely to use them. Surveys of crossing movements over a 12-hour period (7am–7pm) are carried out to establish the numbers of people crossing. These are normally recorded in 15-minute intervals for each 50m section of road, so that the busiest lengths of road and the main "desire lines" for pedestrians and cyclists can be identified. This survey should be supplemented by the observations of an experienced engineer at the site to determine the best location for the crossing.

People generally want to cross roads at or near junctions. If the junction is signal controlled then a pedestrian/cycle phase can be introduced to accommodate this desire line. However, at a priority junction (controlled by a yield or stop sign) a zebra or pelican crossing may be required. In this case there is a balance to be struck between convenience for pedestrians and safety. In general, pelican crossings should not be closer than 20m to junctions (particular care is needed at roundabout approaches where drivers may mistakenly think the junction is signal controlled and not yield at the roundabout) while zebra crossings should not be closer than 5m.

Visibility

Drivers approaching crossings need adequate visibility of the crossing so that they can stop if required. The required visibility distances for drivers to be able to see the near-side primary signal of the crossing or a pedestrian stepping onto a crossing are outlined in Chapter 10, Table 10.2. Pedestrians should be able to see approaching drivers and be seen by them. Visibility should not be obscured or restricted by trees, parked vehicles, signs lamp columns etc. If this is difficult to achieve consideration should be given to the following:

- building out the footway and moving the primary signal pole to improve visibility
- providing high mounted signal heads
- providing signs warning of the crossing and "SLOW" markings
- relocation of the crossing to a point where visibility is adequate
- preventing parking on the approaches

A reasonable balance between visibility and placing the crossing in the desire line will often need to be struck.

Guardrail (Primary Distributor roads only)

Guardrail is provided to guide people to cross at the correct position and discourage people from crossing on the approaches where they are at greater risk of being injured. The type of guardrail specified should provide good visibility of (and for) pedestrians and cyclists. Some traditional forms of guardrail can block a driver’s visibility of small children, because the acute angle of approach causes the vertical bars to line up and block visibility. High visibility guardrail should be specified to avoid this problem. This type of guardrail has a bar pattern, which allows drivers and pedestrians good visibility. A minimum clearance of 450mm between the guardrail and the kerb edge should be maintained as the guardrail could interfere with cyclists on the road.

High-friction surface

Many of the accidents that occur on crossings involve vehicles failing to stop and running into the rear of a vehicle in front of people on the crossing. The risk of such accidents increases significantly if the road surface is wet. Consideration should be given to the provision of high-friction surfaces on the approaches

High-friction surface (UK)

Uncontrolled crossing point

to a crossing. Where provided, in a 30mph speed limit a length of 50m should be provided on each approach and should be applied through the stop line to the nearer limit of the crossing walkway. On higher speed limit roads a greater length should be applied.

Facilities for the mobility/sensory impaired

People with a mobility/sensory impairment require the provision of specific facilities to assist them in crossing the road. This is dealt with in more detail in Chapter 13.

Dished crossings

Dished crossings should be provided at all crossing points whether controlled or not. They will assist cyclists, people in wheelchairs and people with prams and pushchairs. A ramp slope of 1 in 20 is desirable, where possible but it should not be steeper than 1 in 12. The kerb face at the crossing should be flush with the carriageway or a maximum of 6mm high, so as not to form a barrier to wheelchair users or a trip hazard for less able pedestrians. Whilst this may cause some concerns over the ponding of water, it should be possible to alleviate such problems by careful design and construction. The crossing points and approaches should be kept clear of gullies, chambers and inspection covers. Appropriate tactile paving should be provided at all crossing points (see Chapter 13).

Lighting of crossings

It is important that all crossings are well lit. The lighting should highlight pedestrians and cyclists both approaching the crossing and on the crossing. The best way to achieve this is to provide specific lighting for this purpose at both sides of the crossing to ensure that people can be seen.

Lighting of crossing points

12.7 References

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10. TA leaflet 1/01 – The Use of Puffin Pedestrian Crossings – DETR (UK). Available from DETR Tel +44 20 7271 5169

11. TA leaflet 10/93 "Toucan" – An Unsegregated Crossing for Pedestrians and Cyclists – DETR (UK), Available from DETR Tel +44 20 7271 5169

12. TA 4/98 Toucan Crossing Development – DETR (UK), Available from DETR Tel +44 20 7271 5169

13

chapter 13 Facilities for Mobility Impaired People

13.1 Introduction

In Great Britain surveys carried out by the UK Office of Population, Censuses and Surveys (OPCS) during the 1980s showed that 142 people per 1000 of population, aged 16 and over had some form of physical, sensory or mobility handicap. One in ten adults had some form of locomotive handicap.

When account is taken of adults accompanied by small children, those encumbered by shopping, those temporarily slowed down by illness or pregnancy, and frail elderly people, around 1 in 6 adults are mobility impaired in some way. The most common mobility impaired person is an adult pushing a buggy

With respect to sight impairment, around 1 in 60 are blind or partially sighted people, 5% of whom have no sight at all. Sight impairment includes limited field of vision, loss of central vision, acute short-sightedness, uncontrollable oscillations of the eyeball, and night blindness.

Many blind people use a white cane to detect obstructions and changes in level, for example a kerb or step. Some use a guide dog that has been trained to guide the person around obstructions and stop at changes of level.

Access and road safety was investigated in a study carried out by TRL in the UK.[1] This study looked at accidents involving visually impaired people using public transport or walking and was questionnaire based (UK police and Irish An Garda Siochana accident report forms do not record whether a pedestrian was visually impaired).

The main results of the study were:

- 29% have been involved in an accident whilst crossing the road
- Of those involved in accidents, 11% were at pelicans, 6% at zebras, 8% at traffic lights, and 75% at no designated crossing point
- 11% of those involved in accidents were told it was safe to cross by another road user and were then struck by a vehicle

Wheelchair users having problem with kerb upstands

It is clear from the mobility statistics that large numbers of particularly vulnerable people are potential road users, mostly pedestrians. These form a significant minority of the population and their needs should be taken into account in the design, construction and maintenance of the road network.

Loss of sight, hearing and mobility poses great problems for affected road users. Kerb upstands can be trip hazards for pedestrians and cause access problems for wheelchair users. Flush kerbs are desirable but can cause problems for sight impaired pedestrians who may be unable to detect them and may inadvertently walk into a dangerous situation such as live traffic. The provision of appropriate tactile paving and other indicators can greatly help these road users. However, tactile indicators are sometimes incorrect or missing. This chapter gives guidance on the use of such tactile devices together with further references and contacts.

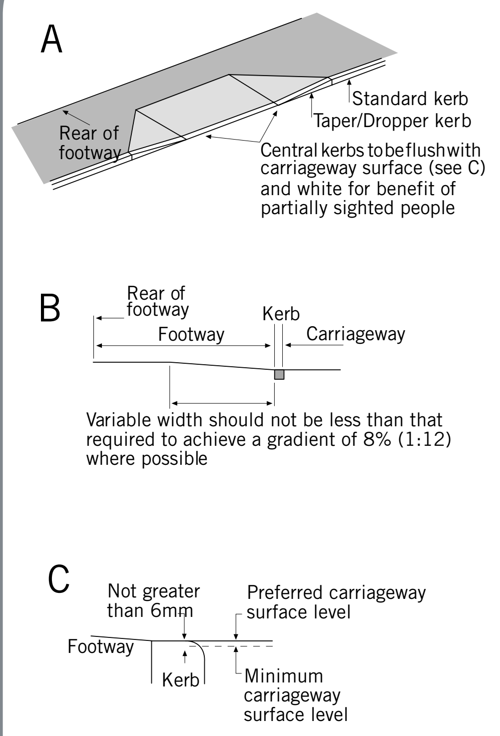
13.2 Design, construction and maintenance issues

The way that footways and crossings are designed, constructed and maintained will have a major impact on how safely these vulnerable road users can travel. Good design can encourage use. Poor or misleading design may be dangerous, and can discourage people with mobility impairment from travelling independently. This can lead to them becoming more excluded from the rest of society. People with sight impairment require guidance to safe crossing points like zebras and pelicans, and warning of hazards such as dropped kerbs and cycle tracks. People in wheelchairs and persons pushing buggies require smooth low gradient transitions between the footway and road at crossing points. Both road user groups require uncluttered footways free of obstructions with sufficient width to pass any potential obstructions and other pedestrians. Providing mobility/sensory impaired people with good facilities need not be expensive, it is often about getting the detail right.

Barriers and hazards to mobility/sensory impaired road users include:

- insufficient footpath width (especially on islands in staggered crossings)

Diagram 13.1 Dished Crossing



- absence of dished crossings. These should be provided at both controlled and uncontrolled crossing points
- poorly designed or constructed dished crossings with excessive ramp slope or significant kerb upstand. A ramp slope of 1 in 20 is desirable with a maximum of 1 in 12. The kerb should be flush with the road surface or have a maximum upstand of 6mm (see Diagram 13.1)
- trip hazards such as kerb upstands, sunken chamber covers, cracked or loose paving
- absence of tactile indicators at controlled crossing points (see 13.3). Tactile paving, tactile push button units and audible bleepers should be incorporated into crossings. The push button units should be located on the right hand side within 500mm of the crossing lines so that vision impaired people can easily locate them.
- obstruction of the footway by parked cars, advertising boards and street furniture such as litter bins, bollards, sign posts, signal poles etc
- inadequate illumination of potential hazards. High-pressure sodium lighting provides a better quality of light and can improve colour definition and crime deterrence. Lamp columns should be located at the rear of footways so as not to cause obstruction. Mounting the lamp units on walls can be considered in appropriate areas

Cranked signal poles allow push buttons to be sited close to the crossing and provide clearance from passing vehicles without obstructing the footway

Advertising board blocking footway

13.3 Tactile paving

Tactile paving is used to provide information to vision impaired people. It can be used either to guide them to specific features or warn of potential hazards. Tactile paving provides a colour contrast to standard footway and road surfaces. Tactile paving units also have a variety of surface textures to help vision impaired people differentiate between the facilities which it guides them to, or warns them of.

Tactile paving (blister surface) is most often used to guide vision impaired people to a controlled crossing facility. This can also be used to provide a warning at locations where there is a kerb upstand of 25mm or less (for example footway crossings, and traffic islands). Without the paving, vision impaired people may find it difficult to determine where the footway ends and the road begins at such locations and could therefore trip or inadvertently walk out onto the road.

Other forms of tactile paving can be used to guide vision impaired pedestrians through a particular area, for example a pedestrianised street. It can also be used to provide warning on segregated cycle tracks and footways, steps, and at bus, train and tram stops. Further information on these uses is available in "Guidance on the use of tactile paving surfaces".[2]

The paving units are laid in a variety of configurations to suit the location or type of facilities. Layouts should be simple, logical and consistent. A clear colour contrast between the paving and the footway is important. The quality of lighting at points where tactile paving is used is also important. Poor quality lighting and certain types of lighting such as low-pressure sodium lights can make colour differentiation more difficult for the visually impaired. High-pressure sodium lighting provides better colour differentiation.

Controlled crossings (see also Chapter 12)

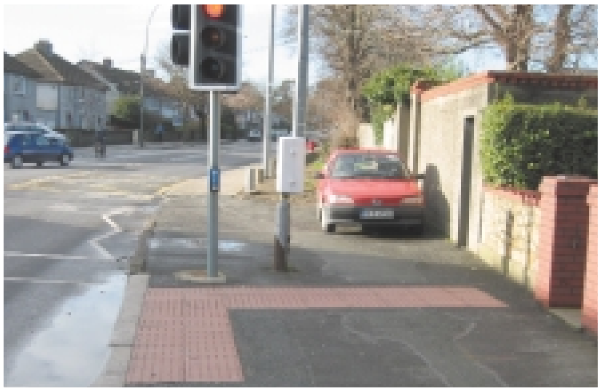
Red tactile paving units only should be used at signal controlled crossings and zebra crossings to guide vision impaired people to the crossing point. The paving units should be laid in an L-shape as shown in Diagram 13.2 (See also Table 13.1)

In order to do this the stem of the paving should be extended to the back of the footway to intercept people who might otherwise walk past the facility. The stem should be 1200mm (3 slabs) wide.

At the crossing point, the tactile paving should be laid across the full width of the dropped kerb (but not the taper kerbs). This should be a minimum of 2.4m wide and should be 800mm (2 slabs) deep. This may require some cutting of the paving units to ensure that they are correctly orientated. The 'dimples' on the tactile paving units should be aligned so as to guide vision impaired pedestrians directly to the other side of the crossing.

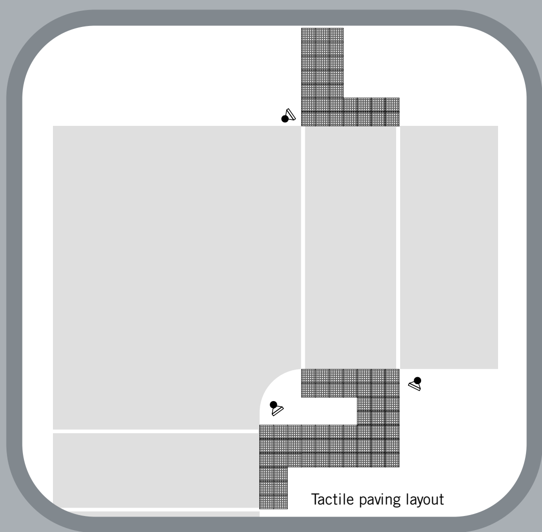
Crossings should be perpendicular to the road (where possible) and provide the safest and most direct route. Crossing points should always be dished.

Blind person at crossing



Tactile paving slabs

Diagram 13.2 Layout at signal junction with pedestrian phase



The top of the dropped kerb at the crossing should be painted white for the benefit of partially sighted pedestrians. Chamber and inspection covers should be located outside the crossing and its approaches where possible. If this is unavoidable, the tactile paving units should be laid into recessed covers to maintain the consistency of paving (see Picture 13.6). Signal controlled junctions without a pedestrian stage should be treated as uncontrolled crossings.

Treatment of traffic islands and staggered arrangements at controlled crossings

If a traffic island is not intended as an area for pedestrians to wait then tactile paving should not be used at the island. An example of this would be at a controlled crossing point with a splitter island where the signal sequence allows pedestrians to cross the whole width of a road at once.

At locations where a traffic island is provided to allow pedestrians to cross a road in two (or more) parts then tactile paving should be provided. If the island is 2m wide or less, then the tactile surface should continue all the way across it (see Diagram 13.4). If the island is greater than 2 wide, then a gap should be left between adjacent strips of tactile paving (see Diagram 13.5). It may be necessary to cut the paving units to fit the available space.

If a crossing is staggered then the layout should be as shown in Diagram 13.6.

Uncontrolled crossings

The layout and colour of the tactile paving at uncontrolled crossing points are different to those for controlled crossing facilities. This is because the purpose of the tactile paving is to warn vision impaired pedestrians that there is a reduced kerb upstand (less than 25mm) at the edge of the road (and prevent them inadvertently walking out into the road) rather than guide them to a safe crossing point.

Diagram 13.3 Layout at zebra crossing

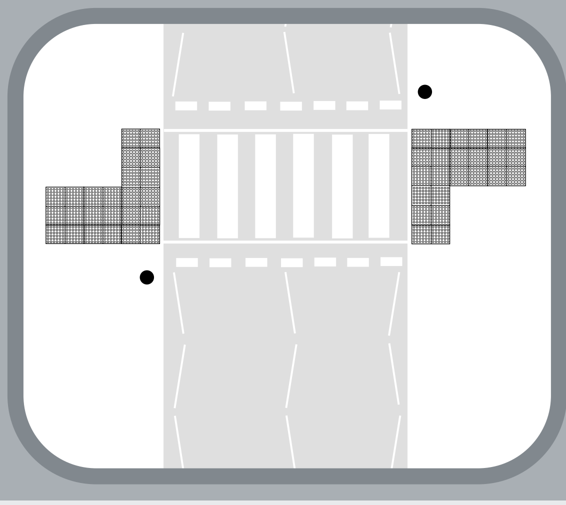


Diagram 13.4 Layout at traffic island 2m wide or less

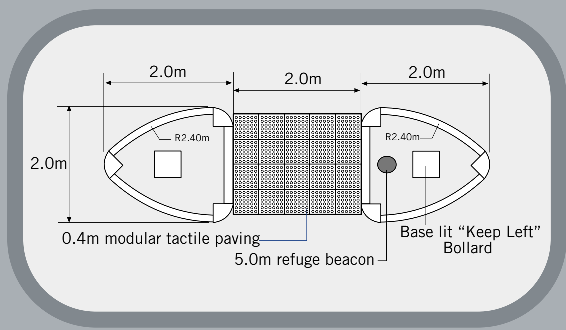
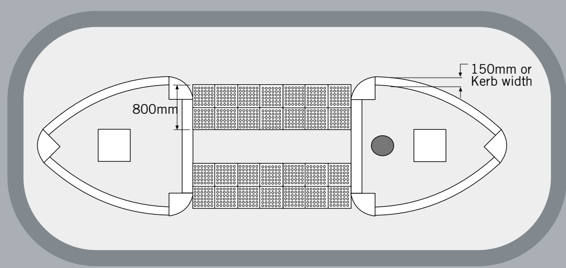


Diagram 13.5 Layout at traffic island greater than 2m wide



Grey or buff tactile paving should be used but with no "stems" at the following locations:

- raised entry treatments
- speed tables
- traffic islands
- dished crossings
- dished crossings at traffic signals without a pedestrian stage

However, it may not be possible to provide tactile paving at all existing locations and therefore the provision of such facilities may need to be prioritised. In deciding relative priorities, discussions should be held with local groups representing both vision impaired and restricted mobility (such as wheelchair users) pedestrians. Tactile paving should be provided at the locations listed above where new works are being constructed.

Table 13.1 summarises the main points of the use of tactile paving. Further details are given in "Guidance on the use of tactile paving surfaces[2]"

13.4 Audible and tactile devices for controlled crossings

At signal controlled crossings, audible bleepers emitting a pulsed tone are normally used during the pedestrian green period. There are two types of push button unit in common use (see Chapter 10.3 – push buttons).

However, there are difficulties using audible signals in the following situations:

- at a staggered crossing facility with each side having independent operation
- at traffic signals with split pedestrian phases (operating on a "walk with traffic" basis)

It may be difficult for the vision impaired or people with hearing deficiencies to establish exactly which crossing movement the audible signal applies to. This could lead to pedestrians stepping into live traffic. "Bleep and sweep" crossings have been used in these circumstances. These produce separate distinctive tones and the audible range is restricted to minimise any potential confusion.

Diagram 13.6 Layout at staggered crossing

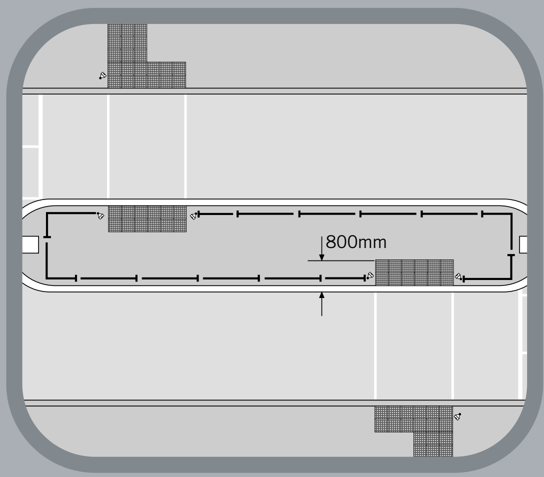
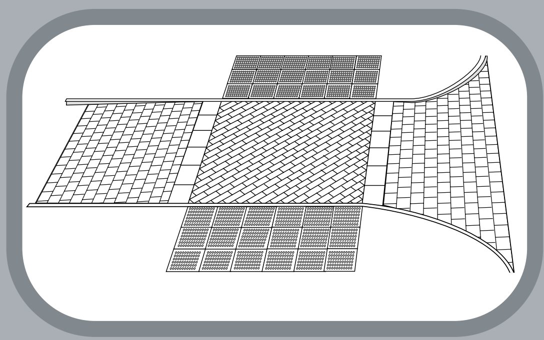


Diagram 13.7 Layout for raised entry treatment at a junction



Audible bleepers may cause noise intrusion in residential areas and in such cases the bleeper can be turned down or if necessary switched off overnight. However ambient sensitive noise units are recommended for these locations. Where an audible signal cannot be used, an alternative tactile indicator should be used (see Chapter 10.3 – push buttons).

13.5 Basic design dimensions

Facilities should be designed to accommodate all road users expected to use the facilities where possible. The following basic dimensions are required by different groups of pedestrians and cyclists:

- a wheelchair requires a length of 1140mm - 1500mm and has a passage width of 900mm
- a wheelchair plus a person pushing requires a length of 1750mm and has a passage width of 900mm
- an adult plus a guide dog requires a length of 1500mm and has a passage width of 1100mm
- a pushchair plus a person pushing requires a length of 1900mm and requires a passage width of 670mm–1100mm

Further information and advice on improving facilities for the mobility impaired is given in "Reducing Mobility Handicaps[3]".

TABLE 13.1 DETAILS OF TACTILE LAYOUTS AT CROSSING POINTS

Use	Colour	Shape	Width of blister paving
Controlled crossing facility	Red	Varies (see below)	
1. On footways at either side of road		L shape	Stem 1200mm wide kerbside 800mm/ 1200mm at inset[a] or 1200mm at in-line[b]
2. On central islands (refuges)		Kerbside	800mm wide at each side if greater than 2m wide or full width if less than 2m wide
Uncontrolled crossing point	Grey or Buff	Varies (see below)	
3. On footways at either side of road		Kerbside	800mm wide at inset[a] crossing point 1200mm wide at in-line[b] crossing point
4. On central islands (refuges)		Kerbside	800mm wide at each side if greater than 2m wide or full width if less than 2m wide

[a] Inset crossing is away from a junction

[b] In-line crossing is at junctions in line with direct pedestrian movement

13.6 References

1. TRL Project Report 82 – Accidents involving visually impaired people using public transport or walking, TRL – UK. Available from the Transport Research Laboratory, Crowthorne, Berkshire RG11 6AU, Tel +44 1344 770783/84

2. Guidance on the use of tactile paving surfaces – DETR (UK), Available from The Stationery Office, PO Box 276, London SW8 5DT. Tel +44 870 600 5522

3. Reducing Mobility Handicaps, Towards a Barrier-Free Environment – Institution of Highways and Transportation (UK). Available from IHT, 3 Lygon Place, Ebury Street, London SW1W 0JS

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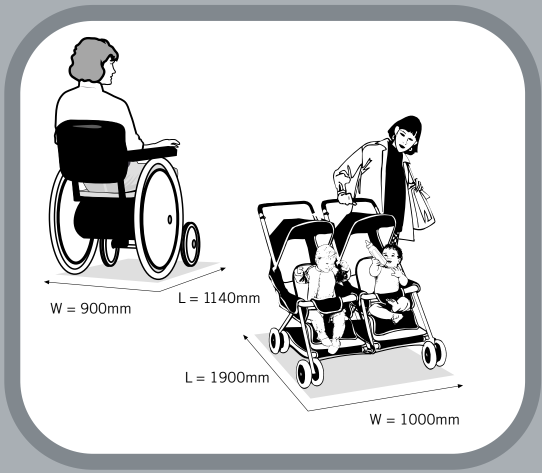
   Drumcondra,
   Dublin 9.
   Tel: 01 830 7033
   Email: heather.hunter@ncbi.ie

Diagram 13.8 Dimensions required by pushchairs and wheelchairs



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chapter 14 Road User Audits

14.1 Role of road user audits

Many road and traffic management schemes are introduced primarily for motor vehicles and can be detrimental to other road users. Road user audits are a way of representing the needs of different road users within the road design process. The main categories of road users that should be considered are:

- cyclists
- pedestrians
- people with mobility/sensory impairment
- motorcyclists
- Public transport

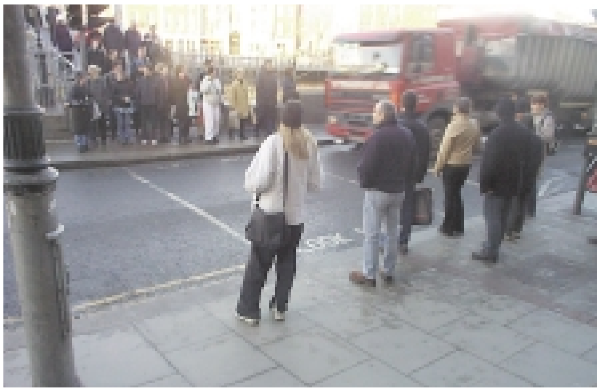
There will also be occasions when it is necessary to take into account the specific needs of other road users such as equestrians.

The purpose of the road user audit is to ensure that road designs take into account the particular needs of the various user groups and that conditions are not made worse as a result of introducing schemes. Designers can also seek to introduce features that encourage walking, cycling, use of public transport and facilities for the mobility/sensory impaired. Road user audits are different from road safety audits (which deal only with road safety issues), and look at both amenity and safety issues. Inevitably there is an area of overlap between the two types of audit.

The DTO and its agencies are developing checklists and procedures to assess the design of transport proposals from the point of view of safety, pedestrians, cyclists, buses, cars and goods vehicles.

Road user audits check the design and operation of schemes. The brief for a project should outline how road users' needs are to be taken into account and how road user audits should be carried out. This should ensure that a scheme is developed in line with a road authority's policy for walking, cycling and mobility/sensory impaired road users. The audits should be

Pedestrian disadvantages by traffic management scheme



Lack of traffic indicators for vision impaired pedestrians carried out independently from the design team and at specific stages of the development of a scheme (see Chapter 14.2).

There are a number of benefits to be gained from carrying out road user audits. These include:

- encouraging walking and cycling in line with sustainable transport objectives
- reducing perceived safety problems to encourage mobility for the vulnerable road users
- assisting in the provision of schemes to manage the demand for vehicular road space
- demonstrating that schemes have adequately catered for the needs of all road users (see Chapter 12.1)

Incomplete marking of cycletrack at vehicle access

Example of poor design

14.2 Policy and procedures

The process of road user audit is one that is still developing. In the UK, some authorities have developed road user audit checklists for designers to use as part of the general design process. This reduces the risk of designs failing to cater adequately for all road users and helps designers to provide facilities that are friendly to all road users. Road user audit should be applied for all vulnerable road users rather than just for one group of users such as cyclists. Cycle audits are becoming more common and some authorities are developing procedures for formal pedestrian and mobility audits.

Road authorities should consider whether a system of road user audits should be implemented for the design and construction of schemes in their area. In order to set out a policy and procedure for carrying out road user audits, a number of issues need to be considered by the road authority.

Which schemes should be subject to audit?

It is necessary to subject a wide variety of schemes to the road user audit process if a significant impact is to be made. The following schemes should be considered

- road improvement schemes
- traffic management schemes
- development schemes
- new roads
- major maintenance schemes

Which standards and good practice guidelines should schemes be audited against?

It is necessary to have some standards and advice on good practice for comparison in order to assess the adequacy of the measures being proposed. A number of reference sources are given in Chapter 14.4.

When should the audit take place?

Audits should be undertaken at key stages of the development of a scheme such as:

- feasibility design
- preliminary design
- detailed design
- post-construction

These key stages are applicable for medium and larger schemes but for smaller schemes some of the stages such as feasibility/preliminary design can be combined. This also generally fits in with the timing of road safety audits, which should be carried out separately and after the road user audits to ensure that any proposals made are as safe as possible.

Who should carry out the audits?

At the formal key stages, the road user audits should be carried out independently of the design team, by someone with specialist knowledge and understanding of the issues involved. It is useful to give designers a checklist to aid the design process. The checklist should highlight the issues to be considered, good practice and references for the provision of appropriate facilities. Examples of unacceptable practice or scenarios to be avoided can also help.

Which road users should be considered?

Pedestrians, cyclists, mobility/sensory impaired road users, public transport users and motorcyclists should be considered. It may also be necessary to consider equestrians where appropriate.

14.3 Design issues and common problems

The main design issues and common problems are dealt with in Chapters 12 and 13. Sources of advice on good practice and further references are given in Chapter 14.4.

14.4 References

1. Provision of Cycle Facilities, National Manual for Urban Areas – DTO/DoELG. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

2. Reducing Mobility Handicaps, Towards a Barrier-Free Environment – Institution of Highways and Transportation – UK. Available from IHT, 3 Lygon Place, Ebury Street,
London SW1W OJS

3. Guidance on the use of tactile paving surfaces – DETR – UK. Available from The Stationery Office, PO Box 276, London SW8 5DT. Tel +44 870 600 5522

4. Guidelines for Cycle Audit and Cycle Review – Institution of Highways and Transportation – UK. Available from IHT, 3 Lygon Place, tEbury Street, London SW1W OJS

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section f Public transport

15

chapter 15 Public Transport

15.1 Introduction

Role of Public Transport

Public Transport has a key role to play in getting the optimum people carrying capacity from the transport network. Fixed track systems such as rail and Light Rapid Transport (LRT) have a substantial role to play in this in the bigger conurbations. Although expensive, the advantage of such systems is their potential to move large numbers of people efficiently. Journey time, safety and reliability are important operating factors. It is important that they operate independently of general traffic for as much of their journey as possible. The interface with other road users such as pedestrians and cyclists needs to be designed carefully for safe and convenient access.

Encouraging the use of the bus however through initiatives such as Quality Bus Corridors (QBC) will be the key to improved movement in most sections of the urban environment. The provision of high quality, frequent and reliable bus services is essential if people are to be attracted out of their cars on a wider scale.

Buses have the ability to move large numbers of people around urban areas in a safe, economic and relatively environmentally friendly manner. To achieve their full potential, buses not only have to be able to move around the road network with a minimum of delay, but they have to be able to pick up and set down passengers quickly and conveniently. A comprehensive and high quality approach to the provision of public transport and its associated infrastructure is required if a significant modal shift is to be achieved.

The average car occupancy rate on a peak hour journey in the Greater Dublin area is 1.4 persons. The average peak hour bus carries around 54 people[1] so it is over 38 times more efficient than the car in people movement terms. On congested routes, increased use of buses can help to reduce the effects of congestion or to increase people movement capacity, by the introduction of bus lanes as well as other innovative bus priority measures.

For many people living in outlying or rural areas, the car may be the only choice for the journey into a town or city. The use of strategically positioned and well designed park and ride (see 15.4) facilities may give these people a real alternative for the part of their journey where the effects of congestion are most acute – into and out of the town/ city centre.

Promoting Public Transport

As the sustainability of travel is becoming the focus of future transport policy, public transport must receive high priority when planning road infrastructure. It is important that public transport is given priority at locations where it would otherwise be delayed by other traffic eg in/out of public transport interchanges, approaching junctions, on main exits from residential developments onto main roads.

If people are to be tempted out of their cars then public transport and the advantages it offers should be promoted on a wider scale. A holistic approach to the provision and promotion of public transport is needed.

15.2 Quality Bus Corridors

Quality Bus Corridors (QBCs) are a partnership between bus operators and road authorities. The bus operator agrees to provide a high quality, frequent bus service along specified routes whilst the road authority provides infrastructure such as bus lanes, bus priority measures and improved bus stops.
The Dublin Transportation Office has set out a Specification for Quality Bus Corridors[3] that has the following objective: "To provide a clearly defined, high performance bus transportation system segregated from other road traffic"

The development of a strategy of improving facilities for public transport along an entire route or corridor can achieve substantial improvements in bus operating times and passenger usage. These improvements together with targeted publicity about the benefits of QBCs by both the bus operator and the road authority can help to achieve a substantial increase in bus patronage and remove car trips from a congested route.

The introduction of the N11 Stillorgan QBC in Dublin resulted in an increase in peak period bus trips from 3,000 to 5,000 people. Corridor travelling capacity (people) has increased by 700 people per hour and journey times reduced by 15%.

The infrastructure requirements of each QBC, in order of priority, are that it:

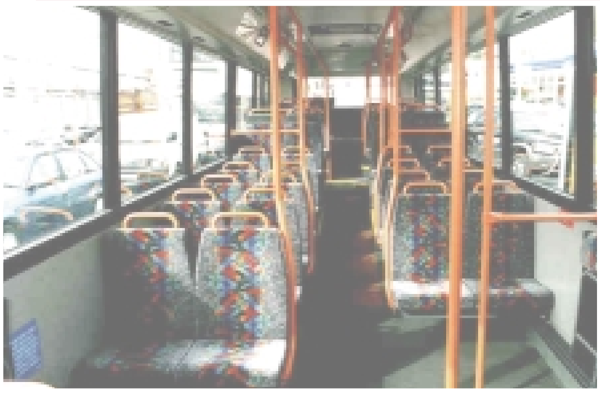
- starts on a Regional or higher classification road
- provides access priority for bus services entering the QBC
- delivers bus journey speeds on the QBC of at least 20 km/h average over the whole corridor
- increases by a minimum of 20% the capacity of the corridor to carry people when all modes are taken together
- operates on segregated lanes on the complete length of the corridor wherever the road width allows
- operates on non-segregated lengths to the highest possible performance levels by the use of traffic management techniques
- links through an intelligent interface to the Urban Traffic Control system (SCATS or SCOOT or similar)
- operates wherever possible on a 12-hour basis with a specified period for loading if required
- maintains wherever possible priority through roadworks the occurrence of which should be cleared with the bus operator
- discourages intrusion by general traffic by being clearly defined and using coloured surfacing where necessary
- provides bus stops positioned to minimise walking times for existing and potential passengers taking into account issues such as security, traffic conditions, etc
- encourages use by having high quality waiting areas at all principal bus stops, including shelters, seating, telephones, ticket vending machines, cycle parking and boarding platforms
- informs passengers at high usage bus stops with real time passenger information

Stillorgan QBC

Parking at QBC bus stop

- provides a high quality running surface with a maximum camber of 2.5% together with vertical alignment transitions at junctions engineered to reduce the potential for the oscillation of buses passing through
- includes a network of pedestrian walking routes to bus stops that are landscaped, well lit, direct, with safe road crossings.

Low Floor bus



New high quality buses

These priorities recognise that increasing service frequency, reliability and reducing journey times will help to achieve a long term modal shift. However, people want a higher level of service in terms of availability of real-time travel information and better quality buses. Bus stops should be designed to minimise passengers concerns about personal safety. Better integration of bus provision with high quality walking and cycling routes with secure cycle parking facilities will help to ensure more people travel using sustainable modes of transport.

On some of the successful QBCs, some of the principal bus stops on the corridor have become key modal change points. People will drive to these locations to use the bus and leave their cars in residential streets, church car parks etc. near to the bus stops. This has resulted in localised commuter parking and access problems in the immediate vicinity of the QBC stops.

It is therefore essential that when a QBC is being planned these possible side effects should be considered and appropriate measures taken when the QBC is introduced. In some cases it may be necessary to review existing bus stop locations to ensure that adequate and safe parking is available nearby. It may be necessary to consider the need to provide off-street car parking (as at a railway station) at some potentially heavily used sites, or to review local waiting restrictions at locations where long stay parking is inappropriate.

In addition to the road infrastructure improvements, QBCs should also be the focus of network and fleet changes by the operators. Routes could be revised and re-routed to take advantage of the timesaving that a QBC can make possible. The introduction of newer vehicles, with user-friendly features such as low floors for disabled access and facilities for push chairs can help to lift the profile of public transport in the area and give a potential boost to usage.

It is intended that the bus service on a QBC shall:

- provide an agreed level of passenger waiting times at all boarding points on the corridor
- operate so that passenger boarding and alighting times at bus stops is a maximum of 12% of total bus journey time
- minimise passenger interchange by integrating services into cross-city formations
- offer an integrated ticketing system such that one passenger payment is required for any trip, irrespective of the number of modes required.

It can be seen that a successful QBC cannot be implemented by the actions of traffic engineers and planners alone. It requires the co-operation and input of the operators, An Garda Siochana and the adjacent residents and businesses to be successful. A partnership approach will ensure that good quality facilities designed to attract people out of their cars will be implemented to the overall benefit of the community.

15.3 Bus lanes and bus priority

Bus lanes are provided to improve the journey time and reliability of the bus services. Bus lanes allow buses to get to the next junction more quickly. The reallocation of road space to provide dedicated lanes for buses is a very positive way of improving the people-carrying capacity along a particular route. A bus lane carrying one bus every five minutes has the same capacity as a lane carrying around 1000 people by car. Increasing the frequency of the bus service to one every two minutes could increase the people-carrying capacity of the lane by 250%.

Sometimes bus lanes are criticised by other drivers as they see the lane empty for long periods of time. In order to avoid this it is important to increase the bus service frequency to ensure that the people-movement capacity of the lane increases substantially and that the benefits are widely publicised.

Bus lanes at junctions

Use of Bus Lane by Emergency Vehicle

Bus lane markings

The Traffic Signs Manual[2] gives details of the signs and markings that should be used for bus lanes. The bus lane markings should be continued with a dashed line across the bellmouths of minor roads. At roundabout and traffic signal junctions, bus lane markings ideally should continue up to the stop line. Where left turn facilities are permitted, the line should be dashed in advance of the junction. Downstream of the junction, the bus lane should re-commence immediately on the far side of the junction. At signalised junctions, it is the general objective that all approaching buses can negotiate the junction in one cycle of the signals.

Bus lanes should be a minimum of 3.0m wide and ideally 4.5m wide to allow buses to safely overtake any cyclists using the lane (see Cycle manual for more specific advice). The use of coloured surfacing for the bus lane can help to discourage unauthorised usage by other vehicle drivers.

Contra-flow bus lanes

Contra-flow bus lanes

The majority of bus lanes are 'with flow' but the use of 'contra flow' bus lanes can help to provide more direct routes for access by passengers where there would otherwise be lengthy diversions around one-way systems. Contra-flow lanes can help to save on journey times and operating costs. When used in busy shopping and commercial zones they can maintain better access for bus routes while keeping the overall level of traffic down. Contra-flow bus lanes generally operate on a full time basis to avoid confusion for other drivers and so that unauthorised vehicles do not use them to take short cuts through an area. Contra-flow bus lanes should be designed with accompanying cycle facilities.

Periods of operation for bus lanes

The period of operation of bus lanes should be consistent in a town or city to avoid any potential confusion. Where there is sufficient demand, bus lanes can operate at all times but an operating period of 7am to 7pm covers the period when most traffic is using the road. Some bus lanes operate only in one or both of the peak hours (e.g. 7am to 10am and 4pm to 7pm) depending on when buses experience the most delays to their service. Bus lanes that operate over longer periods of the day and week are likely to have fewer problems with infringements by other vehicles because the restriction is likely to be better understood. The hours of operation chosen for a bus lane should represent a balance between the benefits for the bus service in terms of reduced travelling times and the needs of local residents and businesses for parking and loading. In striking that balance, the needs of cyclists must be borne in mind.

Parking and loading

If bus lanes are to be successful, then measures should be taken to prevent their obstruction by vehicles that are parked or waiting to load/unload. A single vehicle obstructing a bus lane can cause substantial increases in journey times and delays for buses. Arrangements for local parking and loading should be considered as an integral part of a scheme, when coming to a decision over which hours the bus lane will operate. Loading and unloading should not be allowed during the hours of operation of the scheme and it may be necessary to make alternative provision for these requirements such as:

- the provision of parking/loading bays outside the bus lane
- servicing local businesses from nearby side roads
- arrangements for servicing outside the hours of operation of the bus lane
- active enforcement of restrictions

Use of bus lanes by other vehicles

Pedal cycles are allowed to use with-flow bus lanes. Unless there is a segregated cycle track, then where there are high numbers of buses and/or cyclists then a wider lane (up to 4.5m) will be needed to allow safe overtaking of the slower moving cyclists (see cycle manual).

Taxis are allowed to use with-flow bus lanes.

Emergency service vehicles responding to emergency calls are allowed to use bus lanes.

Mini-buses and coaches with a PSV licence are allowed to use bus lanes because they have the potential to transport large numbers of people.

Motor cycles/mopeds are not allowed to use bus lanes at present. Although they take up less road space than cars the case for allowing them to use bus lanes is more difficult. There are concerns that pedestrians crossing the bus lanes through a queue of stationary cars may not be expecting relatively fast moving motorcycles to be in the bus lane and that there could be accidents as a result.

High occupancy vehicle lanes have been introduced in some countries. Vehicles with two or more people in them are allowed to use the lanes, which offer priority over other traffic lanes at locations where there is congestion. These offer some incentives for higher occupancy trips but could hinder the operation of bus lanes if introduced more generally. They can also lead to enforcement difficulties.

Enforcement

For bus lanes to achieve their optimum operating potential it is essential that adequate enforcement is carried out to prevent their use by unauthorised vehicles and to ensure that illegal parking and loading does not take place to the detriment of the free flow of buses. Consultation with An Garda Siochana, residents and businesses fronting onto the scheme should take place at the design stage to ensure that as many potential enforcement problems as possible are designed out.

Enforcement of bus lanes (especially heavily used ones) is an important element in their success. Longer periods of operation (such as 12 hours) tend to pose fewer enforcement problems. If conventional enforcement resources are too stretched to provide adequate coverage of the bus lane network then consideration can be given to the use of automated enforcement (eg enforcement cameras). These can be used to detect offences and to deter infringements.

Bus priority

Buses can be given priority on links by the use of either 'with flow' or 'contra flow' bus lanes. In certain areas bus-only streets can be designated to provide improved access for public transport.

However since much of the journey time delay for buses is caused by the operation of junctions, measures to give buses priority at junctions can make major improvements in their operation.

Buses can be given priority at traffic signals and allowed access in areas restricted to other vehicles to make their operation more efficient.

Buses can either be fitted with active transponders that carry information about the individual vehicle and its route, or passive devices that simply identify it as a bus and give it priority treatment at certain facilities. The passive devices are normally relatively inexpensive and can be as simple as an inductive loop in the road or a "credit card" that can be read remotely by fixed roadside equipment when placed in the window of the drivers cab.

These devices can be used to call-on a specific signal phase for buses at traffic signals, (for example where a turning movement is banned to all other traffic but is allowed to enable buses to access a specific street or residential area). They can be used to open physical features such as "Bus only entry" (usually controlled with barrier arms or rising bollards) at road closures where buses are permitted but non-essential traffic is banned. Bus only entry can provide useful public transport links in residential or town centre areas whilst keeping through traffic out.

More complex devices (using Global Positioning System (GPS) technology or roadside beacons) can also be used to locate and monitor the progress of individual vehicles along a route. This can provide data to give priority to buses at traffic signals and can be linked up with adaptive UTC systems such as SCATS. Bus priority measures such as bus advance areas and bus gates at traffic signals are dealt with in more detail in Section D, Chapter 10.

Rising bollard at bus only entry

Public Transport Permeability in Residential Areas

It is important to ensure that new developments are highly permeable in terms of the ability of buses, and also pedestrians and cyclists, to move through and between adjacent housing developments. Mechanisms such as priority routes (green routes) for buses with car restraint measures can place sustainable transport modes at an advantage over the car in terms of accessibility and travel times. In particular, examples here would include ensuring that in larger developments, distributor roads offer routes where local bus services can access the entire development without entering circuitous and time consuming cul-de-sacs. Connection of such loops between housing developments by bus only routes can offer faster ways for buses to access residential areas.

While the first priority is to ensure that adequate "green routes" are provided for buses through new housing developments it is also important to examine the possibility of retrofitting them into larger existing developments. This can be more difficult due to existing site constraints but in some cases it may be a feasible and worthwhile proposition.

Pedestrian Permeability

If public transport is to be viable, the shortest access for residential areas needs to be identified and provided. It is essential that Local Authorities review the barriers to pedestrian permeability and develop a policy and programme to open up inter-estate linkages geared towards access to public transport, schools and employment.

15.4 Park and Ride[9,10]

This section should be read in conjunction with Chapter 16 (Parking).

Many trips to town and city centres originate from outlying areas that are not well served by public transport. Park and ride offers car drivers the opportunity to use buses for part of their journey. This can help to reduce congestion and can be an attractive alternative to high cost town/city centre parking. Park and ride facilities can be attractive because they offer either low cost or free parking combined with fixed low cost fares. They can reduce the number of car trips in the most sensitive areas of a town or city. The provision of park and ride facilities should be considered as part of an integrated transport policy and strategy. In particular it should be consistent with the overall parking and public transport strategy.

Park and ride facilities are transport interchanges and the best examples integrate all modes of surface transport including rail. Such sites offer major benefits to promoting the use of public transport as a viable alternative to the car.

Park and ride sites should:

- be located on the fringe of congested areas close to the main national or regional routes with good access
- be of a well-laid out open design with high quality street lighting to reduce fears for personal safety
- include secure parking for vehicles and cycles, which are monitored by either by a permanent staff presence or by CCTV. Facilities with people present throughout the period of operation give a greater sense of security. This can be achieved by providing for some local services such as a shop or bus drivers' canteen facilities in the design
- have good public transport links into the town/city centre areas offering better journey times than by car. This will require buses to provide an express service avoiding picking up further passengers along the route
- offer a frequent (every 10 minutes) low cost service using high quality modern vehicles. Passengers should have ready access to information about operation times and frequencies. Major park and ride sites work on the principle that there is always a bus waiting to take passengers

- offer a significantly lower overall cost than for town/city centre parking. Most locations offer free parking and charge for bus travel. If a park and ride is located close to residential areas then some passengers may walk to the park and ride sites to take advantage of lower fares. This needs to be taken into account in the overall strategy for public transport in the local area as this could result in a shortfall in receipts on conventional services that pass close to the site.

Bike and Ride

Bike and Ride

There are numerous successful examples of bike and ride facilities throughout Europe. The provision of good secure cycle parking at rail, tram and bus stopping places has encouraged the concept of "Bike-and-Ride" where passengers arrive by cycle and complete their journey by public transport.

15.5 Bus stop design

Appropriate location of bus stops is essential as they automatically generate pedestrian crossing demands on the roads served by the bus. It is preferable that bus stops are located in advance of crossing points from a traffic and safety viewpoint. Despite all the investment that can be made in service improvements and road infrastructure, passengers are unlikely to be attracted to buses in the long term if their experience is unpleasant or one of inconvenience. It is therefore necessary to invest in the provision of high quality bus stops and reliable up-to-date journey information.

Traffic engineers, planners and bus operators need to ensure that roadside bus stops provide a good level of service to passengers. This can include the provision of seating, telephones, cycle parking, CCTV surveillance, etc. They must be clean, well lit and offer a secure environment reasonably well sheltered from the elements. At principal stops on QBCs the passengers are likely to park their cars in close proximity. This should be taken into account at the planning stage.

Bus stops must also be user-friendly for bus drivers. They should be able to manoeuvre their vehicles to the kerb without difficulty. Drivers should have unobstructed access at all times. This may be difficult given the many demands placed on road space. However, if a consistent approach to bus stop provision is adopted across a whole area and adequate enforcement is provided, the job of the bus driver can be made easier.

Kassel Kerb at bus stop

Parking

Indiscriminate parking in the vicinity of bus stops causes problems for passengers with mobility problems. Good design can discourage parking in areas that would restrict access for buses. A programme of upgrading existing conventional kerbside bus stops on principal bus routes will help to encourage increased use particularly by those groups that find access difficult at present. If this is not possible then consideration should be given to imposing waiting and loading restrictions to allow easy access.

Passenger access arrangements

As a general rule, all bus stops should be designed to accommodate the current generation of low-floor buses. For these user-friendly vehicles to operate as intended it is essential that traffic engineers understand the basic operating requirements at bus stopping facilities.

For ease of access, buses should be able to manoeuvre the entry/exit platforms right up to the kerbside. Gaps of 100mm or more can present access difficulties for some users such as the elderly; people with push chairs or wheelchairs and people with sight impairment or with walking difficulties.

The optimum kerb height at a bus stop to cater for these persons should be around 180mm. All new bus stops and improvements to existing ones should be designed to this height. Special kerb units such as "Kassel Kerbs" (or similar) are available which give this upstand. They should contrast in colour with the footway.

In addition to giving good access for bus users, high kerbs can discourage casual parking at bus stops. It should be noted that if high kerbs are provided and drivers cannot get clear access to pull up close to the kerb (because of parked vehicles for example) the situation for less mobile people that require better access to buses will be made worse. They will have to step-down from a high kerb into the carriageway and then have to climb up onto the bus platform.

Kerbside bus stops

Kerbside bus stops are only advised within bus lanes, or other traffic lanes where parking is not allowed. They should be supported with Kassel type kerbs.

Bus bays (lay-byes)

Bus bays are advised principally on high frequency bus routes (eg QBCs) in order to facilitate buses overtaking other buses, and/or on distributor roads (outside schools, hospitals etc.) for safety reasons. Horizontal reverse access should be used when setting out the entry and exit kerbs for bus bays, as far as practicable.

In congested urban locations, bus bays can become parking and loading bays, forcing the bus to stop on the main carriageway, with passengers having to make their way through the parked vehicles. This is a major problem for the mobility impaired and causes access problems for people with wheelchairs, pushchairs, etc. Most existing bus bays take up a large amount of footway space (at least 2m depth by some 50m length) yet do not adequately cope with the dynamic movements of modern buses. Kerb build-outs within the bay (Diagram 15.1) or conversion to a half width bus boarder (1m deep, see Diagram 15.2) could assist in making these more user-friendly.

Bus boarders

Bus boarders are either full width (2m wide, Diagram 15.3) or half width (1m wide, Diagram 15.2) kerb build-outs and are a good solution to providing easy access for passengers and buses. In heavily parked areas, a bus boarder should extend out into the carriageway beyond the stationary vehicles giving the bus driver the opportunity to pull up in the correct position for ease of boarding and alighting. Bus boarders also provide space for improved passenger waiting and information facilities whilst allowing 180mm height kerbs to be installed. A full-length bus boarder is around 12m long (the equivalent of two parking spaces).

Bus promontories

Bus promontories (Diagram 15.4) are short (2m to 3m kerbside length) versions of bus boarders which can be useful on roads

Diagram 15.1 Conversion of bus bay

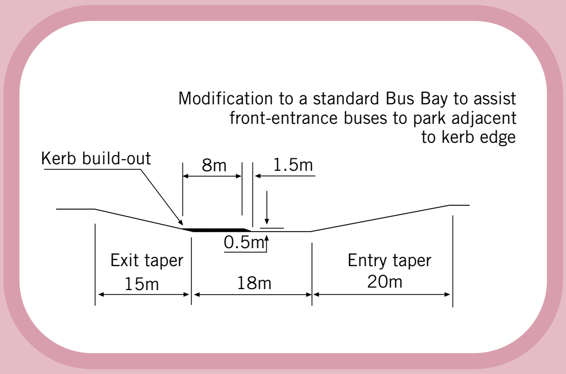


Diagram 15.2 Half-width bus boarder layout

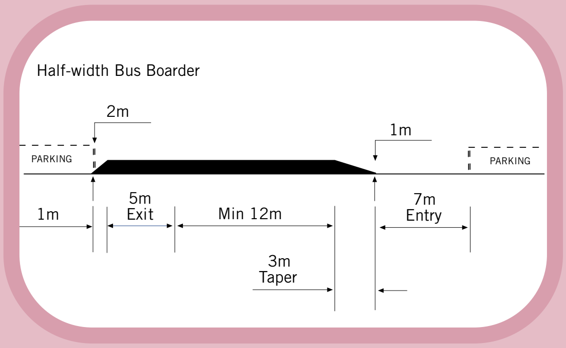
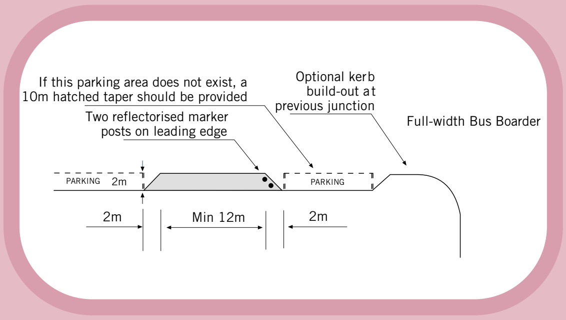


Diagram 15.3 Full width bus boarder layout



where kerbside parking space is at a premium or where it occurs with vehicles either parked at an angle or at right angles to the kerb. Bus promontories give passengers a protected route through the parked vehicles to the raised kerb. However, the disadvantage is that passenger waiting facilities cannot be provided immediately adjacent to the bus stop. They can generally be used only with single-door, front entrance buses.

Articulated Buses & Coaches

These vehicles have very specific stop requirements. Accordingly, bus service providers should be consulted on the proposed fleet in advance of any bus stop facilities being finalised.

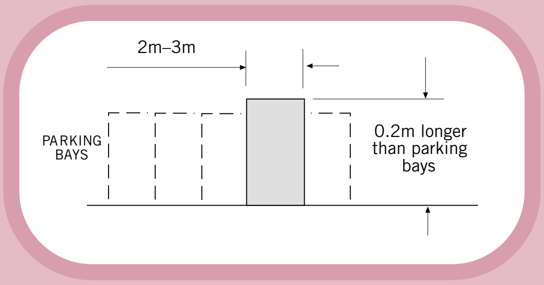
Lighting

Each bus stop should be immediately adjacent to high quality street lighting such as high-pressure sodium lamps. This gives a better feeling of security to waiting passengers during the hours of darkness. It can also assist safe boarding and alighting for passengers. Where bus boarders or promontories are provided, reflective bollards and lighting will be required to highlight the kerb extension into the carriageway.

Passenger shelters

High quality shelters are essential, as the majority of journeys will start with passengers having to wait at the roadside for a period. Shelters do not have to be fully enclosed (in fact certain designs can be perceived as a potential security risk) but, where possible, should be sited so as to provide protection from the prevailing wind and rain. The side of the shelter on the bus approach side should provide good visibility of buses. Seats or a form of "resting rail" should be provided for passengers to lean on. They should be constructed from materials that are vandal resistant and can be cleaned easily. For security reasons shelters should be illuminated and should be located in highly visible areas well away from dense planting. The structure should stand clear of the ground to avoid drainage problems and to ease cleaning. High capacity litterbins should be provided as people often eat, drink and smoke, while waiting for their bus.

Diagram 15.4 Bus promontory



Poor bus stop layout

Street furniture

The street furniture around bus stops must be carefully considered. Where footway widths are restricted it is easy for them to become cluttered. This can cause problems for wheelchair and pushchair users and people with visual impairment. For example it is not unusual for the central entry/exit on a bus to be rendered unusable due to the poor siting of a passenger shelter or adjacent pedestrian guardrailing. Careful design could lead to the integration of the many essential elements that should be at each stop. For example lighting, service information, sitting/resting facilities, litterbins, even public telephones could be incorporated into one passenger shelter structure.

Good bus stop layout

15.6 Passenger information

Basic requirements

One of the main barriers to new customers using a bus service is the absence of information concerning bus routes and times. Providing information on these matters in a clear and easy to understand manner will help to overcome this problem. The minimum amount of passenger information that is required at all bus stops is the availability of a clear, easily understood, current timetable for all the routes serving the location. This should be produced and displayed in such a way that it is as damage and weather resistant as possible and is readable during the hours of darkness. Each bus stop should have its location (and a name) clearly displayed to enable passengers to reference it to the timetable information provided. This will assist tourists and visitors in identifying their return destination.

Real time information at a bus stop

As well as service information, there should be details of the bus operators with contact telephone numbers for emergencies and a timetable information line for general enquiries. A simplified fare table is also useful, especially at a location where tourists/visitors are expected, or an "Exact Fare Only" operating regime exists. The greater the provision of such information the shorter the vehicle waiting time will be at each stop helping to speed-up the service as well as reducing delay to other traffic in the vicinity of the stop.

Real time passenger information

With recent advances in technology it is now possible and more affordable to provide 'live' or 'real time' information on the current position of buses on individual routes. This helps to eliminate passengers concerns about whether they have missed a bus and when the next one will arrive. The costs of installation of this equipment means that it is likely to be used only at principal bus stops on main bus routes such as QBCs.

At present this technology is still developing (see Section H, Chapter 19) and a variety of systems are in use often as part of demonstration schemes. In future years, the costs will reduce and the on-street hardware will become more robust and vandal resistant.

15.7 References

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8. Guidelines for the Design of Bus Bays and Bus Stops. London Bus Priority Network Steering Group, UK, 1996

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section g Parking

16

chapter 16 Parking

16.1 Parking policy and management

The oversupply of parking has manifested itself in an evening peak traffic problem in all the principal development areas. While traffic filters into car parks during the day, most traffic leaves between 4.30 and 7.00pm exiting onto a limited central network. Therefore the amount, purpose and control of parking is central to any future transport plans. Parking policy is an important element in an authority's overall planning and transport policy. The level of car parking provided, its location, fee structure and enforcement levels can all have a considerable effect on car use and traffic flow patterns. The availability of convenient and affordable parking in an area can influence people's decision on their mode of travel and has the potential to be a powerful travel demand management tool. An off-street parking policy should recognise the role that the provision or otherwise of additional parking spaces can play in encouraging or discouraging travel by car. If demand management policies are being implemented then a reduction in the number of parking spaces may be desirable in congested urban areas. Planning policy may seek to limit the number of parking spaces provided for new developments.

In addition to cars, parking policy should include provision of parking for:

- commercial vehicles
- taxis
- coaches
- cycles
- motor cycles
- people with disabilities

It is important to gain public support for an on-street parking policy. However, there are many conflicting needs for parking and for parking control. For example:

- shopkeepers may want free parking directly outside their shops
- delivery drivers will want to be able to load and unload outside their destination
- shoppers want free or cheap parking near to where they shop
- employees want free or cheap parking near to where they work
- emergency services want routes clear of parked cars
- public transport operators and cyclists want routes clear of parked cars
- residents want free or cheap parking outside their homes for themselves
- commuter parking is not wanted anywhere

Parking needs an overall management approach, which encompasses both on-street and off-street elements. In many urban areas it is difficult to accommodate all of the parking and loading needs that people may have. A clearly defined policy and management strategy will help resolve some of these conflicts. Parking can be a very sensitive issue and it is often necessary to produce a strategy that provides a balance between some of these conflicting needs. Public consultation may be required to explain to the community why various aspects of the parking policy are necessary, in addition to any statutory consultation required for individual schemes.

Parking policy will need to consider:

- different journey types and duration of stay for different users (commuters, shoppers, leisure etc.)
- short stay and long stay periods together with associated parking charges
- enforcement
- road safety

One of the most important elements of car parking policy will be the way in which different users are catered for. For example, an authority may wish to discourage car commuters from parking on-street whilst allowing parking for short-stay shopping. The duration of stay and charges for on-street parking has an important impact on parking policy. For example:

- limited waiting will prevent commuter parking
- short period limited waiting (30 to 60 minutes) encourages high turnover of spaces
- free parking for 30 to 60 minutes followed by an hourly charge encourages high turnover of spaces

Enforcement is a key element in any parking policy. Unless an effective enforcement strategy is in place (by the local authority) any on-street parking policy is likely to be ineffective.

Another important issue is road safety. A policy for on-street parking may need to set certain fundamental rules designed to ensure the safe passage of vehicles and other road users. For example:

- no parking at any time within 50m of a traffic signal stop line
- no parking at any time within 15m of a junction
- no parking during peak hours on all national and regional roads

Cycle parking

16.2 On-street parking

Legislation

Legislation for the introduction of on-street parking is contained in the Road Traffic Acts 1961 to 1994,[1] with details contained in Road Traffic (Signs) Regulations, 1997[2], Road Traffic (Traffic and Parking) Regulations, 1997[3] and Road Traffic (Traffic and Parking) (Amendment) Regulations 1998.[4]

The Road Traffic Act enables road authorities to make bye-laws creating parking spaces on-street and for introducing fees for parking in these places. Before making bye-laws, the road authority needs to consult with the Commissioner and publish a notice of the proposals in a local newspaper. The road authority is obliged to consider any observations made during the consultation process before deciding whether or not to proceed with the bye-laws.

On street pay parking to discourage long stay parking

Enforcement

Good enforcement is vital to the implementation of any on-street parking scheme. An Garda Siochana are responsible for enforcement of parking restrictions, although in the City of Dublin and an increasing number of other urban areas the road authority also has an enforcement role. Parking enforcement based on clamping has proved highly successful in Dublin city centre, while other local authorities have developed strong compliance through the use of parking officials. Early consultation with An Garda Siochana is very important to gain their support for any proposals and to ensure if required that adequate priority is given within their enforcement activities.

Types of scheme

Parking schemes fall into the following general categories:

- Prohibitions of parking which prevent vehicles parking at certain times of the day (single yellow line) or at all times (double yellow lines). Signs indicating the hours of operation of the restriction should accompany the markings.
- Limited parking (either free or with a charge) in marked parking spaces. If a charge is to be levied then this can be made by a variety of methods
  – parking meters
  – pay and display
  – parking discs
  – permits.

There are advantages and disadvantages to each of these methods and it is likely that a combination of methods will be used in a large urban area. The advantages and disadvantages of these methods are summarised in Table 16.1.

Large urban areas are often divided into zones where different management principles could apply. For example:

- central business and commercial district – parking meters or pay and display
- fringe zone (multiple-use) – free limited parking
- industrial area – parking restrictions
- residential area – residents' parking scheme

Dimensions for parking spaces

The Traffic Signs Manual[5] gives details of the recommended dimensions for different types of parking spaces. Parking spaces are generally only marked out on the road when there is a specific parking restriction such as limited parking (free or paid) or the provision of a parking space for a disabled driver.

Diagram 16.1 Parking parallel to kerb

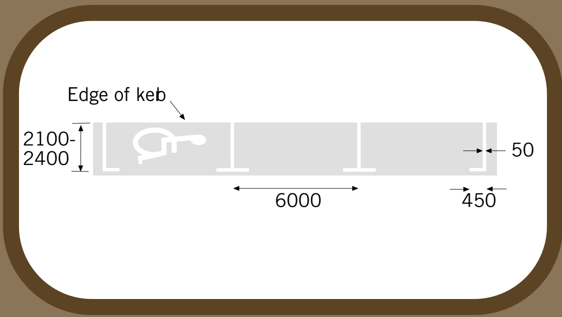


Diagram 16.2 Parking with buffer strips

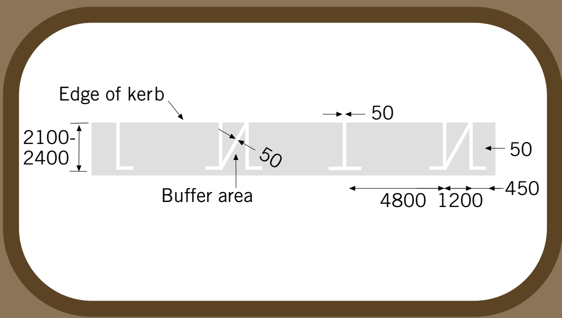


Diagram 16.3 Perpendicular parking

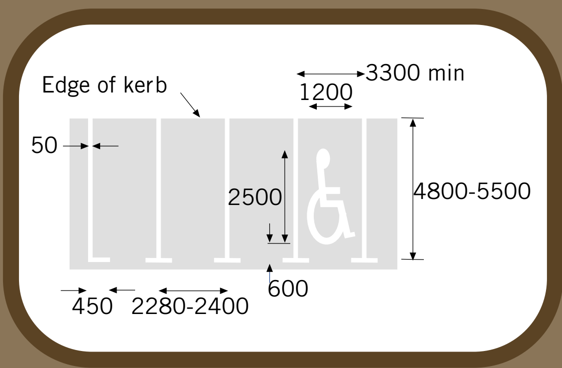


TABLE 16.1 ADVANTAGES AND DISADVANTAGES OF DIFFERENT TYPES OF PARKING SCHEME

Method	Advantage	Disadvantage
Ticket Dispensing Machine (Pay and Display meters)	– Enforcement is relatively easy – Cheaper and less intrusive than meters – Suitable for short-and long-stay – Potential for separate residents' tariffs – Mobile phone interlink possible	– Drivers have to walk to meter – Extra signing is required
Pre-purchase discs cancelled and displayed by user	– Enforcement is relatively easy – Cheap to implement and operate – Environmentally unobtrusive – Price can be changed easily	– Risk of fraud – Need for outlets to sell cards – Inconvenient for visitors
Parking meters	– Detection of non compliance is straightforward – Help to impose physical parking discipline – Generate revenue – Useful for short-stay – Help match demand to supply – Potential of electronic versions	– Relatively expensive to install, operate or adjust to new charges. – Environmentally intrusive – Cannot be used to favour specific user-groups – Can be an obstacle to pedestrians (especially with cycles attached)
Parking permits or Season tickets	– Enforcement is easy – Availability can be restricted to specific types of users – Can be issued for varying time-periods	– No control over duration – Fraud is possible as holders can allow others to use them – Fraudulent requests – Administration effort is required
Time Limited parking	– Cheap to install and modify	– Enforcement is very difficult – Markings and signs can be environmentally intrusive – Need substantial patrolling
Specific permitted-vehicles (eg vehicles for disabled, motorcycles, car pools)	– Spaces can be marked out	– Enforcement can be difficult – Permits need to be displayed when vehicles are used in a specific way

Parking parallel to kerb

Parking spaces parallel to the kerb should be 6m long and 2.4m wide (2.1m minimum). This allows sufficient room for vehicles to manoeuvre in and out of the spaces when other vehicles are parked (see Diagram 16.1). It is possible to provide buffer strips between parking spaces. These guide drivers where to park so that their exit manoeuvres are easier. It also helps to provide adequate gaps between cars for pedestrians to use (see Diagram 16.2).

Perpendicular parking

Perpendicular parking spaces should be 5.5m long and 2.4m wide (4.8m by 2.28m minimum). This type of parking arrangement is more difficult for drivers to manoeuvre into and out of and consequently should only be used on roads with low traffic volumes and speeds, such as traffic calmed residential roads (see Diagram 16.3).

Angled parking

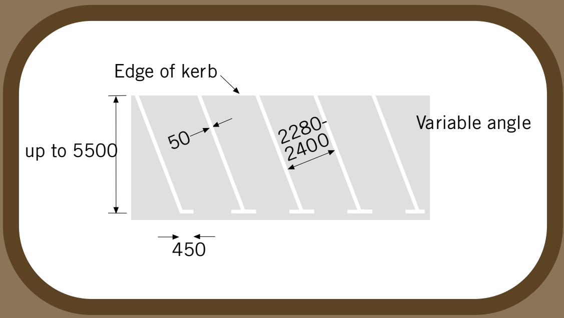
On wider roads or one-way streets with parking on one side only, parking spaces can be angled according to the available road width (see Diagram 16.4). This may help to provide more parking spaces than with traditional parallel parking arrangements. The minimum angle between the parking space and the kerb should be around 30° (less than this produces no significant benefit).

16.3 Off-street parking

Off-street parking fall into a number of categories:

- publicly owned – open to the public. These are often designated either short or long stay with parking charges (if applicable) set at levels which encourage the designated use. Generally more popular (or centrally located) car parks will be designated short stay
- publicly owned – not open to the public (staff car parks, often open to the public at weekends)
- privately owned – open to the public. Many of these are in prime locations in town and city centres and will charge for parking. In contrast there are many car parks which are provided free of charge for employees and customers of specific facilities such as retail or leisure outlets

Diagram 16.4 Angled Parking



Poor car park layout

Solar powered pay & display ticket dispensing machine

- privately owned non-residential (PNR) – which is provided for the employees of businesses (often free) and not open to the public
- private residential – provide for the use of residents of the property concerned.

Off-street car parks can be either single level (often surface-level) or multi-storey. Surface car parks are cheaper to construct and often more popular with users because they generally have less personal security concerns. However, in land use terms, surface car parks occupy a lot of land for the number of spaces that they provide. Multi-storey car parks can provide a high number of parking spaces for the land they occupy. However the design and layout of many of the older ones cause personal security concerns for people because of poor lighting and enclosed layout. More modern designs have addressed these concerns with better quality lighting and open layouts.
Car parks should not be located in Central Business Districts or town centres when vehicle flows associated with them would be likely to cause congestion on the local street network.

Layout and design

The essential element of efficient car park design is to bring vehicles deep into the facility offering a variety of parking options: if parking spaces are available near the entrance, queuing may develop for these convenient spaces. It is important that the parking layout is well designed so that drivers can circulate safely and manoeuvre easily into and out of parking spaces. Car park entrances should be designed and laid out so that drivers do not queue on the public road whilst waiting to enter the car park. Careful consideration should also be given to the design of entry and exit roads to off-street car parks in order to minimise conflict with pedestrians and cyclists. Where conflict between the different modes of travel needs to be catered for vehicle speeds should be kept to a minimum by the use of appropriate maximum radii and lane widths and high angle of entry and exit (close to 90 degrees). Consideration also needs to be given to the capacity of the local street network to cater for the entry and exit vehicle flows associated with any off-street car park development (see Chapter 1.11 for Assessment of Traffic Impacts).

Safe and direct pedestrian routes within the car park should be provided in the design and clearly signed and marked out.

Parking spaces should be provided for cyclists, motorcyclists and disabled drivers. These spaces should be at prime locations such as pedestrian entrances and exits.

The layout of the car park should be open and well lit so that people feel secure and safe. In multi-storey car parks, ramps should be positioned so that vehicles entering the car park drive past the majority of parking bays to assist in finding a space. However those exiting should be able to do so quickly without having to drive past the parking bays. This will increase the efficiency of flow in the car park. If parking charges are levied than the method of payment needs to be considered. Pay at exit can cause problems when large numbers of vehicles are likely to exit at the same time e.g. when offices close. Pay and Display is now commonly used and offers advantages in terms of lower running costs for wardens to patrol.

Management of car parks

Car parks need to be managed to ensure that they are maintained to a high standard. Litter collection, cleansing, removal of graffiti, repairs to items damaged by vandalism and replacement of lighting units should be carried out on a regular and frequent basis. Surveillance by CCTV cameras or regular foot patrols can help to discourage crime and reduce peoples concerns. Maintenance plans should be drawn up and let as contracts (if appropriate). Failure to maintain car parks can lead to increased concerns about personal safety and vehicle crime. This can discourage people from parking in these facilities and lead to an increase in parking on-street, which can exacerbate residents concern over parking spaces and add to existing traffic flow problems.

Signing for car parks

In larger towns and cities it is becoming increasingly common to see active car parks signs which display the directions to car parks and the number of spaces available. These variable message signs can be a useful traffic management tool. Much of the traffic circulating in a town centre at any time is looking for a parking space. The use of these signs can help to direct traffic to the nearest car park rather than having people cruising around looking for parking spaces. If there is major congestion or an incident on a particular route then vehicles can be directed to car parks via other routes which helps to reduce congestion.

Variable message sign

Charging for workplace and private (non-residential) car parking spaces

Many people have free private car parking spaces provided at their place of work. Similarly many free parking spaces are provided for customers at retail and leisure facilities. Charging a levy for these parking spaces that can be passed on to users is being considered by government and some local authorities in the UK as a measure to encourage modal shift away from car use. In Ireland such measures would require new legislation.

16.4 Cycle Parking

Fear of cycle theft (or partial theft/damage) is known to be a significant deterrent to cycling. The National Cycling Strategy in the UK identified cycle security as a key issue. It sets out objectives of improving cycle parking at major destinations, including town centres, shopping developments, educational establishments, hospitals and leisure facilities.

Experience in the UK has revealed the following information in respect of cycle parking:

- Short/Mid Stay Cycle Parking – Short and mid-term parking cyclists will use Sheffield type parking stands, and any convenient items of street furniture.
- Long Stay Cycle Parking – For longer term parking cyclists will tend to seek a higher level of security. This is available from cycle lockers, cycle centres or manned cycle parking. Cyclists may be more willing to pay for such facilities.
- Cycle Centres – Cycle centres offer under cover long term high security cycle parking for a fee. In addition they offer showers, lockers and changing facilities. There may also be the attraction of cycle repairs, and sales of bikes and accessories.
- Cycle parking involving colleges or work as destinations was often well used straight away, with a demand for more. This is not surprising, since these are traditionally areas of relatively high use. Cycle parking at rail stations tends to vary by station.
- Cycle lockers provide additional security, either alone or as an option to standard cycle parking by way of Sheffield stands. Cyclists are more likely to be willing to pay for lockers because of the extra security and convenience they offer. Lockers could be abused by users and a tight system of monitoring and of issuing keys is needed. Coin operated lockers are more likely to suffer from vandalism and theft. Lockers installed at stations can carry a security risk, and need to be designed so that staff can see into them and inspect the contents.
- Closed circuit television (CCTV) can add considerably to the security of all cycle parking provision. In some cases cycle parking can be located so that it benefits from existing CCTV installed to cover car parking.

Location/Signing of Cycle Parking

Cycle parking should be easily accessible to regular commuters as well as to shoppers, visitors and passing trade. This is because cyclists will park informally, if it is easier for them to do so than to seek out designated cycle parking areas. Cyclists will only be prepared to park more than a short walk from their normal parking place if there is a significant gain in security. Cyclists prefer locations where their bicycles are in regular view of local shops or passers-by. Placing cycle parking at or very near cyclists' destinations is important. Shopping centres, theatres, cinemas, leisure centres and libraries are amongst the most obvious places at which cycle parking should be established. Signing to the parking is important, especially for casual users or in tourist areas. Transport interchanges such as train and bus stations are other obvious locations. Cycling can be used for part of a longer journey if secure parking can be provided for part of the trip.

Off street cycle parking, such as at cycle centres or cycle parking in car parks, needs to complement, not compete with, nearby on street parking.

The Cycle Manual contains detailed information and cycle parking and policy options.

16.5 References

1. Road Traffic Act 1994. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

2. Road Traffic (Signs) Regulations 1997. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

3. Road Traffic (Traffic and Parking) Regulations 1997. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

4. Road Traffic (Traffic and Parking) (Amendment) Regulations 1988. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

5. Traffic Signs Manual – Department of the Environment. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

6. Transport in the Urban Environment (UK) IHT 3 Lygon Place, Ebury Street, London SW1W 0JS

7. Traffic Advisory Leaflet 6/99 (Available free from the Traffic Advisory Unit, Zone 3/23, Great Minister House, 76 Marsham Street, London SW1P 4DR Tel. +44 20 7676 2478)

h

section h General

17

chapter 17 Management of Commercial Vehicles

17.1 Classes of commercial vehicles

The movement of people and goods by road is essential to the economic prosperity of a country and the quality of life which people enjoy. However, such movements can cause traffic and environmental problems. Effective management of commercial vehicles needs to form part of an overall traffic management strategy, for towns, cities and their surrounding areas. It is important that individual decisions about restrictions and recommended routes taken at a local level are in accordance with the overall strategy. In most towns and cities road space is at a premium and a balance between ease of access for commercial vehicles and the free flow of traffic will have to made. The environmental impacts of commercial vehicles will need to be carefully considered in sensitive areas such as residential streets and historic or conservation areas.

HCVs and LCVs

For the purpose of this document, a distinction is made between Light Commercial Vehicles (LCVs) which have a gross vehicle weight (gvw) of 3.5 tonnes or less and Heavy Commercial Vehicles (HCVs) which have a gvw greater than 3.5 tonnes.

Light Commercial Vehicles (LCVs) are generally purpose built vans/pick-ups with a carrying capacity smaller than that of HCVs. LCVs generally pose fewer environmental problems than HCVs because of their relatively small size.

Vehicles have rights to pass along roads unless legal restrictions are made to prevent their passage along particular roads or through particular areas. In some areas physical road space may be limited or buildings/structures may restrict access.

17.2 Problems associated with commercial vehicle operation

Whilst performing an essential function HCVs can have a significant detrimental impact on the environment of towns and cities. Many urban areas were not designed to accommodate the size and number of HCVs now using them. Off-street servicing facilities, and road space in these areas can be inadequate for the size of vehicles that require frequent access.

Loading and unloading

Vehicles loading and unloading goods often have to park on the street and this can cause conflict with the needs of other road users including pedestrians and cyclists. This requirement can result in localised congestion and can conflict with other dedicated road uses such as bus lanes.

Noise, vibration and emissions

Many concerns that people have about heavy commercial vehicles relate to the size of the vehicles and the noise, vibration and local air pollution that they can generate.

Noise is generated primarily by the engine, tyres, suspension system and braking system. Noise can also be generated by insecure bodywork or fittings/loads and the effects of wind on the bodywork. Refrigeration units are a particular source of noise especially if running during the night. Occasionally, the inappropriate use of loud audible warning devices (such as horns) can constitute a nuisance. In narrow streets enclosed by buildings the noise can accentuate people's concerns.

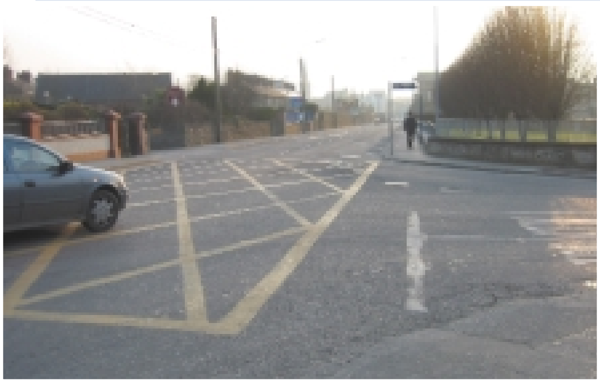
Vibration generated by traffic can be a nuisance, with that from HCVs being higher than for general traffic. Ground-borne vibration reduces as it radiates from a vehicle. The firmer the sub surface the more localised the vibration effect will be. Vibration levels vary markedly with the soil type in an area. BS 7385[1] gives guidance on thresholds of vibration exposure that may give rise to damage to buildings. Vibration (and noise) can be worse when a vehicle runs across a surface defect such as a pothole or a traffic calming measure such as a ramp.

Gaseous emissions from motor vehicles are a major general source of environmental concern. Congestion has a major detrimental impact on localised air quality. Air pollution such as dust, smoke, particulate matter and fumes are also a major health concern. Older or poorly maintained HCVs can contribute significantly to this problem and are often noticed more readily by people. Narrow enclosed streets with significant volumes of HCV movement and servicing needs are likely to suffer the worst localised problems.

Historic building restricts access

Safety

Concerns are often expressed about the speed of HCVs. Their operation can lead to a feeling of intimidation for other road users. However it is often their size, and the noise they generate rather than their actual speed that makes the problem seem worse. Guidelines on the degree of segregation required between cyclists and trucks is included in the Cycle Manual.



Wide junction designed for HGV causes problems for pedestrians

Use of residential roads

The use of residential roads by HCVs causes concern about noise, vibration and safety for residents, and can lead to requests for weight restrictions or access-only restrictions to remove them. Before introducing such measures it is necessary to investigate the cause of the problem. There are a variety of reasons why HCVs could be using residential roads:

- to take short cuts
- to avoid road works and/or delays on their normal routes
- because of poor signing for their destination
- there is no alternative route
- for deliveries
- for refuse collection

If there are problems with trucks using an unsuitable area then the signing for truck routes and industrial estates should be checked first to ensure that it is complete and consistent. Often poor signing leads to drivers getting lost and driving into residential areas to look for their destinations or ask for directions.

Although the occasional use of an unsuitable road by HCVs is unwelcome, it is the constant use of specific routes by larger numbers of HCVs that is of greatest concern.

17.3 Impact on the road network

Heavy vehicles do the most damage to the structure of the road system and lead to concern about historic buildings and structures.

The maximum possible weight of the heaviest vehicle combinations has been increased to 44 tonnes[2]

In preparation for the introduction of 44 tonne vehicles structures have had to be checked and some will have to be strengthened or replaced in order to carry these heavier vehicles. The vehicles themselves are not larger than before but have the potential to carry more goods and cut down on the number of trips required.

Despite legal requirements relating to manoeuvrability, HCVs may overrun footways or verges. This can result in damage to footways and verges and to street furniture such as signs. In addition to the cost of repairs, this can be a source of danger to pedestrians and can cause damage to underground services. Preventing trucks from encroaching onto footways and verges is therefore an important element in planning and design.

17.4 Licensing and planning controls

In order to achieve effective management of commercial vehicles, the movement and parking of HCVs will need to be planned for and regulated. Licensing and planning controls can help to provide and regulate issues such as routing and overnight parking.

Signs damaged by HCV

Where a local authority adopts a broad policy on truck management, the policy would be strengthened if it were incorporated into its development plan. The advantage of this is that a formal plan of this type must be taken into account when decisions are being made on planning applications.

In dealing with a planning application, the authority has to decide whether (having regard to the character of the area) a proposal will attract a significant number of large vehicles and whether access can be suitably located and designed. The difficulty is in striking the right balance between accepting development opportunities for an area, and achieving satisfactory means of dealing with generated HCV traffic.

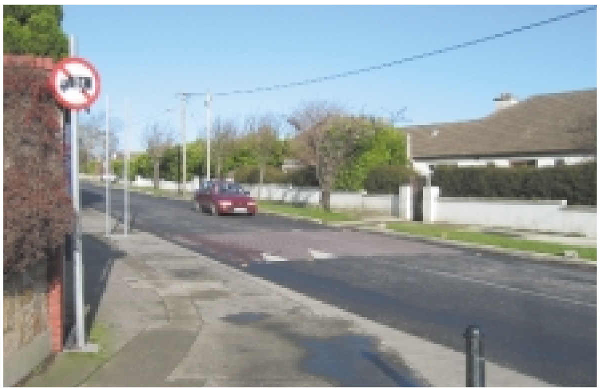
In the case of an existing HCV depot being sited in an unsuitable area, planning controls cannot prevent this use being continued. However, much can be done to encourage the relocation of a goods depot by ensuring that sufficient sites are available in purpose built warehousing or industrial areas with good access to the main road network.

In addition to planning controls, commercial vehicle operators also have to comply with licensing controls. HCV users (with the exception of own account users) require an operator licence, which specifies where their vehicles will normally be kept. Local authorities and adjacent landowners may make objections to the granting of an operator licence on several grounds relating to truck parking, loss of amenity, etc. In addition, environmental protection conditions can be attached to an operator licence to control, for example, the number of vehicles and movements, hours of operation, and parking facilities.

17.5 Signing routes for commercial vehicles

To minimise the detrimental impacts of HCV use on the road network the signing of specific routes for HCVs can be introduced.

Advisory routes have the advantage that they do not rely upon high levels of enforcement to operate. For large numbers of vehicles heading to one destination it is possible for specific advisory routes to be devised. This relies on the presence of a



Weight restriction

HGV route signing

Parking restrictions for HCVs

convenient suitable route. Conflict can however arise when the best available route takes HCVs along roads with significant numbers of residential properties and pedestrian or cycle movements. In practice, "unofficial" truck routes are often created when area wide restrictions on HCV access are implemented, as this often forces displaced vehicles onto adjacent major roads.

Signing is also an important element in any truck management strategy. The first step should be to identify the main destinations on an area wide or route basis and provide special signs to guide trucks along suitable designated routes. The signing should be updated regularly to ensure that it covers new developments. The designation of specific routes and a significant investment in better and consistent signing can help to ease problems. If problems persist, it may be necessary to consider a weight limit or access restriction.

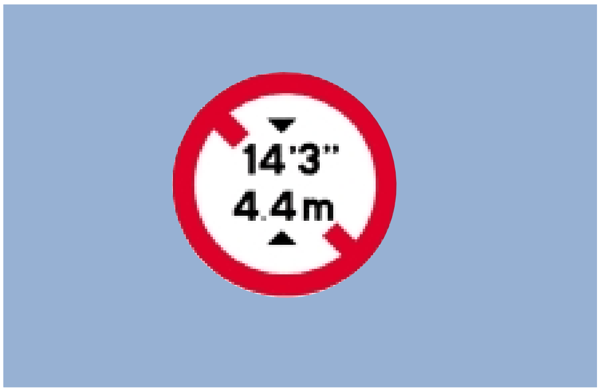
17.6 Area and route regulatory controls

In order to reduce persistent problems with HCVs unnecessarily using sensitive areas such as residential roads, area-wide restrictions on the movement of HCVs over a certain height or weight can be implemented using regulatory signs.

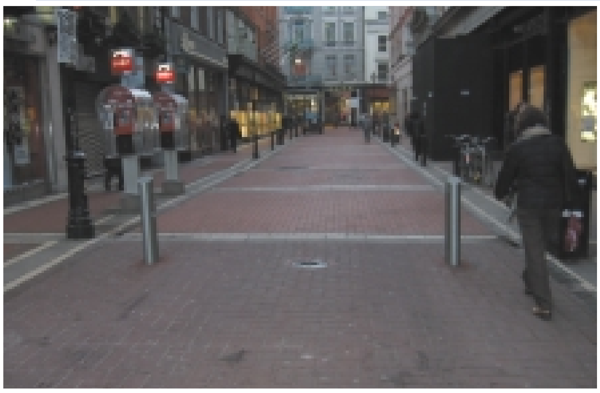
Weight restrictions

Weight restrictions are provided for in Article 17 of the Road Traffic (Traffic and Parking) Regulations, 1997 (SI No. 182 of 1997). These regulations specify that where the unladen weight of any vehicle exceeds the weight specified on the Regulatory Sign (RUS 015), then the vehicle shall not proceed beyond the sign. The only exception to such a restriction applies where it is necessary for a vehicle to enter a road solely for the purpose of gaining access to or from premises accessible only from that road. The Traffic Signs Manual indicates that weight restriction signs should be located on both sides of the road where the restriction commences and should face approaching traffic.

Fibre Optic warning sign



Height restriction



Rising bollard to restrict access

Weight restrictions are used to restrict commercial vehicles over specified unladen weights primarily for 3 purposes:

- to protect weak bridges and other structures from damage
- to restrict use of roads that are considered unsuitable for general use by HCVs
- to protect the amenity of an area

Weight restrictions require signing not only at the point of restriction, but also in advance, at locations where vehicles may turn off other roads to gain access to the restricted section. Lack of sufficient advance warning signs (and turning facilities near to the restriction) can add to enforcement problems. Restrictions that are well signed in advance and alternative routes provided for require less enforcement.

Restrictions can also be applied to the parking of HCVs to prevent drivers bringing their vehicles home or to prevent the development of commercial operations based in residential properties. Figure 5.45 of the Traffic Signs Manual shows a regulatory sign, which can be used to indicate a zonal restriction on the parking of vehicles exceeding a certain unladen weight.

Height restrictions

Where a bridge or other structure causes a headroom restriction, adequate signs indicating the restriction should be provided both on the bridge/structure concerned and on the road approaches to it. Road authorities should be satisfied as to the accuracy of the clearance shown on the signs and their compatibility with any signs provided by the owner, eg Iarnród Éireann. In the case of an overhead railway bridge, the Divisional Engineer of Iarnród Éireann should be notified prior to any proposed works, including resurfacing, so that the dangers arising from any possible raising of the road level, no matter how slight, can be discussed in advance. Article 34 of the Road Traffic (Traffic and Parking) Regulations, 1997 (S.I. No. 182 of 1997) gives effect to a regulatory traffic sign for the purpose of applying a legal prohibition on vehicles over a specified height from passing the sign.

Road authorities should review the signage at all bridge sites with restricted headroom (ie less than 5.03m headroom). It is important to provide the new regulatory height restriction sign on the bridge structure in addition to providing warning signs on the approaches. In the case of rail over road bridges, Iarnród Éircann would fix the signs on the structure and any review of such signage requires a joint approach by the Road Authority and Iarnród Éircann.

Height and weight restrictions are most commonly used to protect structures and buildings that could be damaged by HCVs. Various measures can be employed to minimise the need for enforcement activity by An Garda Siochana. Examples of such measures include:

- Secret signs – fibre optic signs which only display a message when a vehicle that infringes the restriction is detected
- Rising bollards to restrict access to specific vehicles
- Snap-off or demountable bollards to restrict access

Enforcement by physical means such as bollards could cause access problems for buses and emergency service vehicles. Hence consultation with the emergency services, bus operators and bodies representing HCV operators (in addition to any necessary statutory consultations) should be undertaken before these measures are implemented.

In all such schemes at least one unobstructed route must be provided for genuine access needs such as refuse disposal, deliveries, etc. Facilities for vehicles to turn and exit via the same route (if necessary) should also be provided.

17.7 Town and city centres

Towns, cities and villages require frequent access by HCVs to service leisure, shopping, business and commercial needs. In historic centres, roads are often narrow and buildings may be close to the edge of the road. The road layout and servicing arrangements in many areas are not designed to cope adequately with the size and number of HCVs now requiring access. The result is that conflicts with other road users can occur. HCVs loading and unloading can cause congestion. HCVs often park partially on the footway to reduce their effects on motor traffic but this then causes problems for pedestrians, and may result in damage to footways.

An increasingly common way of sharing limited road space more equitably is to introduce pedestrian priority areas. Access for vehicular traffic including deliveries is often prohibited at certain times of day and on certain days of a week when larger numbers of pedestrians are present. This can pose problems for the delivery of goods and services. Operators have to reorganise their schedules accordingly. In planning pedestrian priority schemes the servicing needs of the area will need to be considered and consultation should take place with the owners of properties affected (in addition to any necessary statutory consultations).

17.8 Abnormal and Hazardous Loads

Abnormal and hazardous loads represent only a small fraction of the total HCV journeys undertaken. However by their nature they may cause special problems or concerns. Abnormal loads[2] or vehicles are of a size (height, length and/or width) or weight greater than those normally allowed on roads.

All abnormal load movements are subject to the issue of a permit by the road authority through whose area they pass. The application procedure involves notification of the Garda Commissioner, giving 4 working days notice of the intention to apply to the local authority. Details of the permit procedures are set out in Regulation 59 of the Road Traffic (Construction and use of Vehicles) Regulations (S.I. No. 5 of 2003)[2].

Information which is required by the local authority includes the intended route and times of travel as well as a specification and description for any vehicle to which the permit relates. It may be necessary for the local authority to place restrictions on time of travel (e.g. overnight or at weekends) to minimise disruption to traffic. Paragraphs (10) and (11) of Regulation 59[2] specify the following:

(10) A local authority that issues a permit may attach to the permit any limitations, restrictions or conditions (including in particular conditions as to weight, dimensions, speed, number of trailers, springs, tyres and wheels) which they consider advisable to prevent unnecessary damage to public roads or which, after consultation with the Commissioner, they consider expedient to protect other road users.

(11) A permit may, in addition to specifying a particular public road in a specified area, authorise the occasional use of any vehicle to which it relates on other public roads not specified, subject to compliance with conditions specified by the appropriate local authority, including in particular the condition that before using a vehicle on any such other public road, the person in charge of the vehicle shall inform, orally or in writing, an officer of the appropriate local authority designated for that purpose by the local authority and shall comply with any instructions given by such officer.

Routes for individual abnormal loads can vary because of the weight, height or width constraints at various points along particular routes. Some routes can be circuitous. Road authorities will need to take account of the movement of abnormal loads when considering changes to the road layout that could impose restrictions. It may be necessary to make adjustments to the alignment of schemes to ensure that loads can still pass. Care needs to be taken with the design of new structures, which might place unintended restrictions on the movement of abnormal loads. The use of demountable street furniture may be required.

It is also necessary to transport certain hazardous loads on the road network. There are National Regulations, EU Directives and international agreements governing this subject. There is also a United Nations system for classifying hazardous loads.

Vehicles carrying such loads are required to display plates and carry documentation identifying the loads and details of action required, precautions and evacuation procedures (if appropriate) in the case of a leakage. The name of the manufacturer, and contact number for obtaining specialist advice should also be clearly displayed. In the event of an incident leading to a spillage or leakage emergency services and local authorities may be called upon to deal with the incident, traffic problems, clean up the road and make the load safe and secure.

Hazardous loads normally travel to/from regular locations such as manufacturing plants, warehouses and distribution terminals at ports or railheads. These regular trips lead to the identification of specific routes which can be agreed with the haulage contractors, emergency services, road authority, etc. so that appropriate responses to possible emergencies can be worked out and environmentally sensitive areas avoided.

Service vehicle causing problems

Pedestrian priority scheme

Abnormal load

17.9 References

1. BS 7385 – part 2:1993 Evaluation and measurement for vibration in buildings (UK). Available from The Stationary Office. Telephone orders +44 20 7873 9090, Fax orders +44 20 7873 8200, Enquiries +44 20 7873 0011

2. The Road Traffic (Construction and Use of Vehicles) Regulations, 2003 (SI No 5 of 2003). (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

3. "Trucks In The Community" – A study sponsored by the Civic Trust, the County Surveyors Society, and the Department of Transport (UK). Available from the Stationery Office UK

18

chapter 18 Roadworks

18.1 Introduction

Temporary traffic management arrangements are necessary to allow a variety of works on or near the road, for example:

- routine and major road maintenance
- construction and improvement of roads
- work on services such as public utilities that are buried in the road
- construction and demolition of buildings and structures close to a road

These works can vary from minor street works requiring a short-term temporary lane closure to major traffic management on motorways or dual carriageways lasting several months.

Road authority staff and others involved in the planning and implementation of roadworks must have due regard for the safety of all road users and site workers during the roadworks. The organisations involved have legal responsibilities to the public and to construction employees and these are outlined below.

The responsibility for roadworks generally rests with the client for the works. Where this is not the road authority, the client will need permission from the road authority for certain activities, for example restricting road widths and controlling traffic.

18.2 Planning and control of roadworks

Legislation and guidelines

The Road Traffic Act 1961 (Section 101D as inserted by Section 9 of the Dublin Transportation Authority (Dissolution) Act, 1987) enables a designated local authority to issue Directions to persons carrying out roadworks in its area. The Directions may specify:

- the times when roadworks shall or shall not be carried out
- the period within which roadworks shall or shall not be carried out
- standards of temporary and permanent reinstatement
- requirements for traffic control at roadworks

Dublin Corporation has issued guidance on roadworks contained in Directions for the Control and Management of Roadworks in Dublin City, 1999[1]. The document contains advice to those undertaking roadworks in the Dublin City area. This document includes advice on:

- restrictions on roadworks for various categories of road
- the way in which the council needs to be notified of works
- the way in which roadworks should be signed
- the ways in which the safety of all road users should be assessed

The document has a number of sample forms that need to be completed and submitted to the Corporation.

The Department of the Environment and Local Government issued Guidelines for the Opening, Backfilling and Reinstatement of Trenches in Public Roads[6] in April 2002. This document sets out a summary of the legal framework relating to powers of Road Authorities, various statutory bodies and private individuals in opening or forming trenches in public roads in Ireland. It prescribes standards in respect of the work of forming trenches, backfilling and the reinstatement of road surfaces and the associated materials which should be used.

Safety and Health Plans

The purpose of a Safety and Health Plan is to minimise the risk to site operatives. Under the "Safety, Health and Welfare at work (Construction)

Regulations, 2001[2]", a Safety and Health Plan is required for planning, design, construction and demolition of many projects that will require works to be carried out on public roads. The Safety and Health Plan should cover the planning and execution of the construction phase, which will include any necessary roadworks together with any appropriate assessments of particular risks. Information on the content of such plans is outlined in "Safety, Health and Welfare at work (Construction) Regulations, 2001[2]". This sets out a range of known possible risks and states that control measures to deal with these should be set out clearly. Details of how the regulations affect different types of construction works are also set out in this document.

Planning for roadworks

At an early stage it is necessary to determine which other organisations may need to be involved. For example:

- Road Authority
- An Garda Siochana
- Emergency services
- Public transport operators
- Businesses
- Healthcare establishments
- Education establishments
- Road user organisations
- Public utilities

The planning objective is to complete the work safely and efficiently with as little delay as possible. It should be clear to all road users what they are required to do as they approach and travel through the roadworks.

Issues to consider

The following issues should be considered when planning road works:

- Location of site and nature of work
- Local characteristics of the road section, including horizontal and vertical alignment and visibility
- Specific site characteristics, including road width, speed limit, dual or single carriageway works, and street lighting
- Traffic characteristics, including volume, turning traffic, the traffic mix, traffic speeds
- The number of pedestrians, with particular concern for children, and those with mobility difficulties
- The needs of cyclists and bus users, the position of bus stops in relation to the works
- The need for any site accommodation for workers
- Site constraints such as narrow footways
- Special local events, holidays
- Local amenities and businesses that might be affected
- School crossing patrols
- Any requirement for off-carriageway works
- The requirement for mandatory or voluntary diversions, road closures
- The requirement for temporary traffic lights, temporary speed limits, or "Stop/Go" boards
- The requirement for authorisation of any special signs
- The requirement for any restriction of hours of work – day/night

In the Dublin City area all the roads have been graded into four categories according to their importance as strategic traffic routes. The grading of the route determines the times at which roadworks may not be carried out.

On category 4 roads (the busiest roads) for example, works are not allowed to take place between:

- 07.00 to 19.30, Monday to Wednesday
- 07.00 to 21.00, Thursday and Friday

On category 1 roads (the least busy) for example, works are not allowed to take place between:

- 23.00 to 07.00, Monday to Friday
- 23.00 to 09.00, Saturdays, Sundays and Public Holidays

18.3 Temporary traffic management arrangements

Chapter 8 of the Traffic Signs Manual 1996[3] specifies the signs that can be used at roadworks and describes a variety of layouts for common types of roadworks.

Roadworks are divided into two main categories:

- short term roadworks – works of a minor nature which will be completed in a day or works of a mobile nature such as routine road maintenance, manhole inspection and public lighting maintenance
- long term roadworks – where excavations will be left open for more than a day

Minimum road widths for traffic

It is necessary to provide sufficient width for the site operatives to work safely in and allow routine operations such as excavation and removal/ delivery of materials. Safe access points will need to be identified for these purposes. It will be necessary to provide adequate width for traffic to pass the works safely.

The minimum road widths required for various traffic situations recommended in Chapter 8 of the Traffic Signs Manual are:

- two-way traffic operation – 5.5m (if less than 5.5 the road should be narrowed to not more than 3.7m to discourage two-way operation).
- single lane operation (either one way or alternating with traffic control) 3.0m (2.5m if car traffic only)

In urban areas, for one-way shuttle working, three methods of control are outlined:

- "give and take" – on lightly trafficked minor roads where the length of single lane operation is less than 50m and both ends of the works are intervisible
- a "stop/go" board where the length of single lane operation is up to 100m (a stop/go board is required at both ends if the length of operation is greater than 20m) and operates in daylight hours only
- vehicle actuated (not fixed time) temporary traffic signals where the other two methods are unsuitable

Stop/go board control

Temporary traffic signal control

Further advice is given in Chapter 8 of the Traffic Signs Manual[3]. The cycle time for such works should be kept to a minimum.

On higher speed roads a buffer zone should be provided between the work zone and the road on which there is live traffic. This provides for a margin of safety between traffic and workers. This space should be kept free of workers, materials and vehicles.

Temporary footway

Pedestrian routes

The needs of pedestrians need to be taken into account. It may be necessary to make specific provision for schoolchildren, visually and mobility impaired road users.

A safe alternative route for pedestrians must be provided if the footway is to be closed. Pedestrian access to property must also be maintained. In some cases temporary footways will have to be marked out within the road and they must be adequately signed and protected. Temporary footways should be at least 1m wide, preferably 1.5m or more. They should be marked out with pedestrian barriers that include a handrail and a tapping rail (for blind or partially sighted people). The temporary pedestrian route should be assessed and any hazards such as scaffolding poles should be highlighted. A headroom clearance of 2.1m should be achieved.

Where pedestrian crossings are closed as part of roadworks, it is important to ensure that barriers are placed across the accesses to the crossing, and that signs facing pedestrians are erected to state that the crossing is not is use. Signal controlled crossings should be switched off, and zebra beacons switched off or covered.

Cyclists and Motorcyclists

It is important in a built up area that cyclists/motorcyclists are specifically catered for in a roadworks scheme. Poor surfaces, narrow traffic lanes and ineffective enforcement of speed reductions may lead to unacceptable road conditions for these users.

Detours

If a road has to be closed for a period during the roadworks or sufficient road width to cope with traffic cannot be maintained then detours may be required. When planning traffic detours the following should be considered:

- keeping detour routes as short as possible
- ensuring that routes for diverted traffic are suitable and can cope with the additional traffic
- ensuring that the signing for diverted traffic is clear, consistent and is maintained

When detours are required, advance notification of the detour route and period of operation should be made in local newspapers and by notices along the road affected should be made. This can forewarn drivers and help to ease the initial congestion that often occurs when a detour is first implemented.

Minor works carried out from a vehicle

Certain types of work such as gully cleansing, grass cutting, road marking, etc. are more suited to being carried out in a mobile way rather than a fixed way because the length of road covered in a the period of the works is much greater.

Cones and barriers are omitted and static signing may be provided only at the start of the works. Table 8.1 in Chapter 8 of the Traffic Signs Manual[3] gives details of the levels of warning required for mobile works. The main options are:

- No signing
- Road works signs on vehicles, strobe lighting in poor visibility
- One flagman with or without signs on vehicle and strobe lighting
- Fixed signing

Monitoring the road works

Operational effects of the road works should be monitored periodically throughout the duration of the works. Regular checks should be made to ensure that the build-up of stationary traffic is minimised. Out-of-hours inspections should be made to ensure that the works are maintained in a safe condition for all road users. Contact telephone numbers should be displayed at the road works for people to report any problems with the traffic control or safety of the site.

The operation of long term road works and any resulting problems should be reviewed at progress meetings between the Client's representative, Contractors and other interested parties.

18.4 Designing to minimise the need for road works

Although road works are a necessary aspect of any maintenance programme, it is worth considering some of the steps that can be taken during the design of road schemes that would help to minimise the need for unnecessary road works or temporary traffic restrictions in the future.

Road works are a potential hazard in terms of road traffic accidents, particularly where long-term traffic management is applied to high volume high-speed roads. Studies have shown that:

- During 1998 there were 10 fatal road accidents and 190 injury accidents at road works in Ireland. (Road Accident Facts Ireland, 1998[4])
- The personal injury accident rate at motorways road works sections is 57% greater than on non-works sections (TRL Project Report 37[5])
- The personal injury accident rate at road works on dual 2 lane carriageways is 20% greater than on non-works sections (TRL Project Report 37[5])

Opportunities to "design out" future road works

Giving consideration to maintenance issues within the design of road schemes could avoid some of the requirement for road works in future years.

Some examples are given below:

- Traffic signals are installed sometimes without consideration of how the service engineer can safely access the controller. Signals are occasionally placed in such a position that they can only be accessed from a ladder in the running carriageway
- Grass is often planted in the central reserves of dual carriageways and motorways and then several times a year the road authority has to cone-off adjacent running lanes to cut the grass. This is a risk to operatives and to road users travelling through the works. Even cutting grass on nearside verges can be a high risk operation on some roads
- Consideration should be given to hard surface central reserves where steel barrier is used. This eliminates the need for grass cutting, positive drainage can be provided, litter blows away to the sides and therefore does not need people to pick it up in a danger zone
- Steel barriers are placed in central reserves, requiring lane closures for repairs to be carried out when the barrier has been breached. In some situations concrete barrier could be employed as an alternative
- Building new roads with services under the carriageway should be discouraged. Ducting systems should be provided under the footway, or in association with planting strips if these are required.
- Lamp columns should be at the back edge of the footway. This allows the use of footway and verge by occasional maintenance vehicles freeing up highway space and lessening operative danger

Roadworks can be avoided in some cases by early consideration of future maintenance issues within the design of schemes.

18.5 References

1. Directions for the Control and Management of Roadworks in Dublin City, 1999 – Available from Dublin Corporation Roadworks Control Section

2. Safety, Health and Welfare at Work (Construction) Regulations, 2001 – Available from the Health and Safety Authority

3. Traffic Signs Manual (Chapter 8), 1996, Department of the Environment and Local Government – Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order 4–5 Harcourt Road, Dublin 2 (Tel 01 6613111 ext. 4040/4045, Fax 01 4752760

4. Road Accident Facts Ireland, 1998 – National Roads Authority. Available from NRA, St Martin's House, Waterloo Road, Dublin 4, Ireland

5. TRL Project Report 37, 1993 – A review of the accident risk associated with major roadworks on all-purpose dual carriageway roads – Available from TRL, Tel. +44 1344 770783/84

6. Guidelines for the Opening, Backfilling and Reinstatement of Trenches in Public Roads, 2002. Available from the Non-National Roads Section, Department of the Environment and Local Government, Findlater House, Dublin 1. Tel. 01-888 2273

19

chapter 19 Technology for traffic management

19.1 Vehicle detection, location and control

Advances in technology have led to the development of affordable and reliable equipment that can improve vehicle detection, location and control, to aid the management of traffic.

Vehicle detection systems have been in common use at traffic signals and car park accesses for many years. Technology to selectively detect particular types of vehicles such as buses and emergency service vehicles using roadside equipment linked to signal controllers or a central UTC system (Chapter 10.11) is improving in reliability and accuracy and is becoming more widely used. This will give traffic management engineers greater scope for control of vehicle movements with a minimum of enforcement resources.

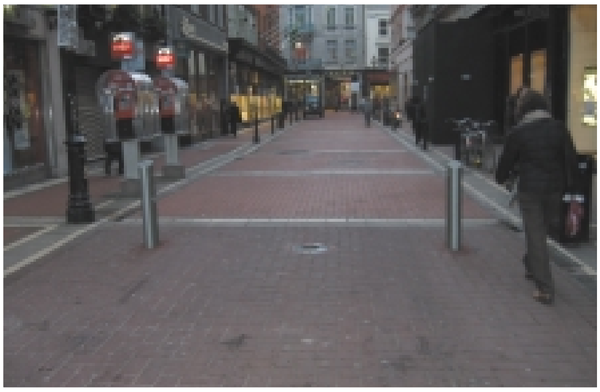
Global Positioning Systems (GPS) are now readily available for motor vehicles. In private cars they are most often used as part of in-car navigation systems, often to help drivers avoid traffic congestion. It can be used by organisations to keep track of vehicle positions and assist in planning routes for pick ups or deliveries, for security/monitoring purposes and to locate accidents or other incidents accurately.

Public transport vehicles equipped with GPS can be linked to real time information systems and offer up-to-date information on arrival and journey times. GPS fitted to Emergency Service Vehicles can assist in route planning to emergencies and give accurate positional information for summoning assistance at the scenes of crimes or traffic accidents.

Technology can help to support access restrictions to certain classes of vehicles (such as general traffic) and allow access by public transport or emergency services It can help to reduce both the resources needed to enforce restrictions and concerns about abuse of the restrictions. Where traffic restrictions are given backing by physical measures such as rising bollards or barriers, emergency service vehicles, buses, etc. can gain access by a variety of means that activate the control feature, such as:

- on-board electronic devices
- card keys

Selective vehicle detection



Rising bollard to restrict access

Another form of access control is the use of queue management or "gating" techniques at traffic signal installations. Signals at pre-selected cordon points can be used to hold traffic queues to ensure the road capacity of an area is not exceeded. This filters traffic into an area to discourage the use of that road link or area by traffic at certain times of the day or year. The reasons for this can relate to air quality management or to congestion reduction in sensitive areas or along sensitive routes. These queues can be bypassed by buses and Emergency Service Vehicles if bus lanes, QBCs, or other special access lanes are provided on the main road.

Trials are being undertaken to test systems for in-car speed limiters linked to engine management systems. Such systems can either advise drivers of the need to reduce speed or automatically reduce or limit speed in response either to roadside equipment or global positioning information. Such technology could also assist in reducing incidents such as trucks hitting low bridges or enforcement of width and weight restrictions. Some of the applications would require action or legislation at European level.

Ramp metering (often using traffic signals) is a form of access control, which seeks to regulate the flow of vehicles onto a length of road, such as a motorway, in congested conditions. The aim of this is to smooth the flow on the motorway and prevent congestion or the normal flow of traffic from breaking down.

Road Pricing Systems (RPS) such as road tolls and or congestion charging systems are another form of access control. Tolls are limited to specific roads at present but their development and use may become more widespread as congestion increases and real public transport alternatives become more widely available. Several cities in the world have already introduced RPS to limit access to central business districts or to discourage drivers from taking their vehicles on to Motorways at peak times. Electronic charging techniques have been developed to make the installation of RPS easier to install and manage. The introduction of such techniques requires new legislation and a political will to tackle the issue.

19.2 Variable Message Signing

The technology for Variable Message Signing (VMS) has been around for many years. Signs directing people to car parks are one of the most common uses of this technology. More recently advances in telematics linked to a control room with incident management systems and computer traffic prediction models, has led to an increase in the number of these signs on motorways across Europe. They can give advice for example on:

- driving conditions such as adverse weather
- alternative routes
- advisory/mandatory speed limits
- congestion ahead
- special events directions
- major accidents
- roadworks or lane closures
- journey time information

19.3 CCTV Surveillance

Closed circuit television (CCTV) is a useful tool for the surveillance of traffic conditions at key or congested junctions and usually forms a part of the equipment in use at traffic signal control centres. It is also in widespread use for security monitoring of public roads in shopping and business districts where it has proved successful in deterring street crime and car theft or vandalism as well as improving people's perception of personal safety.

CCTV can also be used to improve security at car parks, tollbooths, bus and rail stations as well as less busy areas where vulnerable road users could have security concerns. These include remote bus and tram stops, subways, Park and Ride sites, etc. CCTV installations can also be used to monitor access controls, traffic lanes restricted to certain classes of vehicle (QBCs, bus lanes, etc.) and other more general traffic restrictions which would otherwise require a high level of enforcement activity.

Number plate recognition techniques using cameras linked to computer analysis packages can now provide a number of opportunities to help manage traffic:

- measure average speed between two points for enforcement of speed limits
- determine origin and destination information relating to vehicle routes
- improve enforcement of traffic restrictions
- by use with speed cameras
- assist with automation of toll collections

19.4 Automatic Debit and Pre-payment Systems

These systems have been developed to collect toll or other charges such as car parking fees without requiring drivers to stop. In traffic management terms, the main benefits of such systems are to speed up the collection of fees and minimise delays and congestion.

The most common applications are for tollbooths on motorways, tunnels and bridges or for the collection of parking fees. However, they can be applied to road pricing and congestion charging schemes.

The simplest systems use a "smartcard" which is manually inserted into a barrier machine and either debits an account held with the operator or uses up prepaid units held electronically on the card. In more sophisticated systems the vehicle either has a "smartcard" mounted in the window which can be read by external electronic equipment, or they have an internally mounted electronic device which triggers a signal that can be read by the external equipment.

Variable message sign

CCTV at traffic signal junction

19.5 References

1. Intelligent Transport Systems – Realising the Potential Proceedings of Conference held on 5th & 6th November 2002 available on cd from Office of Director of Traffic, Dublin City Council, Civic Offices, Dublin 8. Telephone 01-6722592

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